ENGINEERING NEWS

THE Hudson River Tunnel project is now in the hands of English promotors, and English engineers of no less repute than Sir JOHN FOWLER and Mr. BENJAMIN BAKER are to be responsible for the technical details of the work to be done. The English papers are now inviting investors, as we lately mentioned, to take up any or all of $1,500,000 of first mortgage 5 per cent. bonds of the Hudson River Railroad Co., of New York. Under date of July 30, 1888, Engineers FOWLER and BAKER state that the work already done is substantial and in all respects adapted to the purposes for which it was designed; and that they estimate that the unfinished parts of the tunnels can be opened to traffic in about 18 months, and the north tunnel finished for $900,000 and the south tunnel for about $1,250,000.

IS it an established principle of good railroad management to, "take what you want by force if you can't get it legally"? Certainly one might judge so from frequent actions of railway managers. On Aug. 8, at Tuscola, Ill., the Chicago & Eastern Illinois company gathered a force of men at 3 o'clock in the morning and laid its tracks to the heart of the city before the Indianapolis, Decatur & Western, which disputed its right of way, could gather its force for resistance. On Aug. 9, at Springfield, O. a force in the employ of the Ohio, Indiana & Western Railroad assembled at 4.30 A. M., cut the tracks of the Cleveland, Columbus, Cincinnati & Indianapolis, and laid a crossing to connect their own tracks with the Ohio Southern railway. The enemy were more alert here than at Tuscola and tried to stop the work by pushing up some cars. Their opponents, however, threw them off the track and with one of their own engines knocked a Bee Line engine off the track at High St. bridge, and by 8 o'clock the work they had set out to accomplish was done.

THERE is no question but the frequent aggravating delays in the courts, when right of way matters are concerned, offer a strong temptation to take the quickest way to settle the affair. But a remedy which would be far wiser and would reflect much more credit on the executive ability of railway managers would consist in making such mutual concessions or if necessary agreeing on such an arbitration as would result to the best interest of all parties concerned. So called rival railroad interests are threatened by too many common enemies to make it wise for them to spend time and money in fighting each other.

UNDER date of Aug. 10, news comes from San Jose, Costa Rica, that the Executive Department of that State has approved, accepted and signed the contract negotiated at Washington by Senor PEDRO PEREZ-ZELEDON, special envoy of Costa Rica, and HIRAM HITCHCOCK, president of the Nicaragua Canal Association. Mr. A. G. MENOCAL, who was acting for the Canal Company in Costa Rica, started for the United States on Aug. 13. The ratification of this contract is an important step in the progress of the Canal, as by it Costa Rica grants concessions similar in tenor and form to the Nicaragua concessions, with certain modifications in accordance with the canal's relations to the territorial limits of Costa Rica.

ADVICES from members of the Nicaraguan Canal Survey, to July 14, state that all the parties in the field are well. Mr. HUNT, with the boring party, was in the western division; Mr. MOLINA'S party was near the Serapiqui river; Mr. MILLER was engaged between the San Francisco river and Florida Lake, and Mr. LE BARON, in charge of the survey, was at headquarters at Camp Corazo. Mr. J. H. COVODE, chief of party, and Mr. D. B. MACAULEY, hydrographic recorder, have returned to New York.

IN our issue of Nov. 19, 1887, we mentioned that sawdust was being put up in bales by sawmills in Maine; the work being done by powerful hydraulic presses. We received quite a number of enquiries as to where this baled sawdust could be obtained, but were not able to furnish the information. We have lately seen it advertised in a local paper and for the benefit of our subscribers give the firms a free advertisement. The firms are, Weston & Brainard, of Skowhegan, Me., and The National Wood Co., of Wiscasset, Me. The bales are about 2 ft. by 2 ft. by 3 ft., and are enclosed in burlaps. The material is used for packing purposes, and also for stables.

"THE longest tunnel in the world" item is ever on its rounds in the daily press. But that very ancient chestnut, the 10¼ mile Schemnitz mine tunnel, is again cropping up with exasperating frequency. This Hungarian tunnel is only about 10 by 5 ft. in its dimensions, and its advocates can find no later bore than the St. Gothard to compare it to in length. The fact that the Croton Aqueduct tunnel near this city is about complete, and that it is nearly three times as long and much larger in section than the Schemnitz is too recent an event to attract the attention of these ancient historians.

A partial collapse of the extensive wheat warehouses of the Northern Pacific R. R. Co., at Tacoma, W.T., occurred Aug. 10, being caused by the destructive work of the *teredo* in the supporting piles. Nine warehouses were completed in September, 1887. They are 450 ft. long, and have an average width of 160 ft. The recent failure occurred over about one-eighth of this area, covering parts of the warehouses. The estimated amount of wheat lost is from 6,000 to 10,000 tons. Last March there was a partial failure, owing to a number of the piles having been eaten through; this break was repaired, new piles being driven, and an effort made to protect them by running in sawdust to fill up the spaces between and around the piles. This method of protection proved effectual where tried, but unfortunately the supply of sawdust has so far been insufficient to protect all the piles, and many of them are found completely honey-combed after standing less than one year.

THE rainfall of August 13 was excessive in Providence, R. I. The total registered rainfall was 3.10 ins. in 8 hours; but the heaviest fell at the rate of 3.75 in. per hour. This rate, however, is surpassed by the record of Aug. 6, 1878 in the same city when, as noted in our issue of July 28 last, 4.49 ins. fell in one hour, and 3.5 ins. of this in 36 minutes.

A SUIT is now pending in the Supreme Court between the Barber Asphalt Paving Co. and JAMES BRAND and the National Vulcanite Co. It involves large asphalt interests. The Barber Co. claims that it originated at great cost the use of Trinidad asphalt from an asphalt lake in that island. BRAND held possession of a strip of asphalt around the edge of this lake, and dug it out in such quantities as to endanger the lake itself, and he also encroached on the Barber Co's market in this country. The latter company then contracted to pay BRAND $6,000 and $1,250 monthly not to lay sheet asphalt except in Philadelphia, Boston, Brooklyn and Washington, and not to sell any asphalt for sheet asphalt paving, or for asphalt paving blocks. The Barber Company claims that BRAND has violated this contract by transactions with the Vulcanite Co. and asked for an injunction. Judge INGRAHAM this week denied the injunction, as the case can come to trial in October, and the injury to BRAND would be greater than to the Barber Co. through this injunction.

THE most serious railway accident of the week was a collision at Shohola, near Middletown, N. Y., on the New York, Lake Erie & Western Railroad, August 13. The engine of a freight train running east was derailed by a rock on the track and thrown on the west bound track. Before flagmen could be sent out the Chicago express came up and struck the freight engine with a force that wrecked both locomotives and threw the engine, express, mail, baggage, smoking and first day car of the Chicago express off the track and down an 80 ft. embankment to the bank of the Delaware river. The ruins soon took fire from the engine and burned furiously in spite of the drenching rain. One day coach and five sleeping coaches remained on the track, and no one in them was injured. One man was killed and several were injured more or less seriously.——On Aug. 12 the St. Louis limited express on the New York, Lake Erie & Western Railroad was turned onto a side track near Corning, N. Y., by a misplaced switch, and collided with a Lehigh Valley coal train. One man was killed. Both engines and three cars were wrecked.——On Aug. 12 an engine on the Chicago, Burlington & Quincy road ran into and wrecked some oil tank cars at Chicago. The oil caught fire and the greater part of the train was burnt.

A SERIOUS accident occurred Aug. 13 on the St. Clair electric railway at Pittsburg, Pa. The sprocket wheel, which gears with a rack on the steep grades, broke just as the motor and car approached a trestle. The driver became frightened and jumped off, and the car ran rapidly down the hill. The conductor applied the brakes and kept the four passengers from jumping off. At a curve at the bottom of the hill, the conductor and one passenger were thrown from the car and seriously injured.

THE Philadelphia *Press* is again taking up the old but ever important story of the quality of the drinking water furnished that city. On the authority of physicians the *Press* states that typhoid fever is almost an epidemic there, and it is charged directly to the public water supply. When Col. WM. LUDLOW, as Chief of the Water Department in 1885, made his address to the County Medical Society and told some unpleasant truths in a more generally public way than his predecessors in office, he was requested by a resolution of Councils to desist from statements calculated to alarm the people and injure the city. In the opinion of Councils then the water was purer than in any other American city, save Chicago alone, and some of th present Councilmen are still of the same opinion. Perhaps these particular members are unfamiliar with and uninterested in water as a beverage. Be that as it may, the fact remains that the *Press* has doubtless good reasons for its new crusade. The intercepting sewer lately completed along the Schuylkill river seems to have made that supply better than it was by cutting off the sewerage of Manayunk and other villages. But now the Lardner's Pt. works are charged with pumping polluted water from the Delaware river. This was until lately considered the purest water coming into the city.

STEEL rails weighing 90 lbs. per yard have recently been rolled by the Bethlehem Iron Company of Bethlehem, Pa., for use on the Reading Railroad. These are said to be the heaviest steel rails ever rolled in this country. It is rumored that both the Reading and Jersey Central roads are going to renew the track on their main lines across New Jersey with steel rails weighing from 89 to 92 lbs. per yard,

THE following bridge accident is reported: On Aug. 11 the Mill Creek bridge, on the Hannibal road, near Kansas City, Mo., was wrecked by the washing away of the supports.

THE first train of the newly inaugurated direct railway system between Paris and Constantinople, reached Sofia, August 12. A banquet was presided over by Prince FERDINAND at which congratulatory speeches were made and much enthusiasm concerning the benefits of the system was manifested.

THE monthly statement of the receipts of the Brooklyn bridge show that the receipts for July amounted to $70,281.77, an increase of $8,045.65 over July 1887, but $4,713.63 less than in June 1888. The number of people passing over the bridge in July was 2,543,251.

THE Japanese Government has, according to *Indian Engineering*, finally consented to build piers and otherwise improve the port of Yokohama. The plan includes a 5,000 ft. pier and a breakwater 3,800 ft. long. The funds to be used are said to be the $1,300,000 of the Shimonoseki indemnity returned by the United States and $300,000 advanced by the Treasury.

THE Great Eastern Railway, in England, has recently been troubled by extensive floods near London, which stopped the trains and caused several washouts. In some places the water reached nearly to the floors of the cars. The floods were caused by a tremendous rain storm, which filled the rivers and flooded large tracts of land in the flat county of Essex. The storm is said to have been the heaviest experienced in that county for 25 years.

DURING the week there have been heavy wind and rain storms in the Middle, Atlantic and New England States. A hail storm caused much damage in Adams Co., Ia.——An earthquake shock was felt at Winthrop, Me., Aug. 14.

Electric Traction.

The following matter upon the use of electricity as a motive power is condensed from an article of Mr. G. DE COETLOGON in *Le Génie Civil*:—

For the horse as a motor, the cost of keeping these animals, and the extensive buildings, and large force required to care for them, electricity substitutes one central station equipped in the following fashion:—

(1) Some kind of general motor.
(2) Generating dynamos, or the charge in the case of accumulators.
(3 A motor upon the vehicle operated by the power conveyed or stored.

The author claims that electricity presents a marvelous elasticity, in enabling the management to supply more or less power and velocity as required without an appreciable addition to the expense. And the further claim is made that "existing experiments show that the expense of electrical traction is 40 per cent less" than by the use of horses for the same purpose.

Then follows a description of the three principal systems in use for moving the vehicle itself; leaving out of consideration here locomotives operated by electricity, as requiring a dead weight out of proportion to the service, and as presenting a waste of space in the length of the moving power.

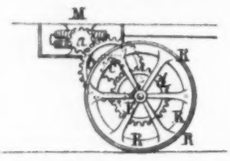

Fig. 1.—Transmission by Gearing.

(1) *By Cogwheels (Frankfort).* Fig. 1. In this system the pinion *a*, keyed upon the axle of the motor *M*, meshes with a wheel *b* with 56 teeth revolving upon an intermediary axle. A second pinion *c* with teeth moves a wheel *d* with 52 teeth fixed upon the main axle *E* of the car. The proportion is thus 6.6 to 1 between the motor and the driving wheels of the vehicle. This motor has a movement of about 500 revolutions per minute. The inconvenience of this system is that it is noisy, and easily broken or damaged.

(2) *By Chain and Sprocket Wheel.* Fig 2. In this machine the motor *M* makes 1,000 revolutions per minute, and carries upon its axle a small pulley *a* the circumference of which is cut in V-shaped grooves. This pulley by a belt of steel wires controls a large wheel *b* with similar grooving, fixed upon the frame of the car. The movement of this intermediate wheel is then transferred to the driving wheel *E* by the aid of a pinion *c* and a sprocket-chain and wheel as shown. This is the system more generally used.

(3) *By Steel Wire and Grooved Pullies (Lichterfeld).* Fig. 3. Here the axle of the motor *M*, fixed in the center of the car, carries a pulley *a* in which the width is about 6 in. and it is cut into 24 V-shaped grooves. Each of the two main axles of the car carries a large belt-wheel *c*. *c'* on its center, with the rim of the belt-wheel cut with 12 grooves. The pulley *a* is placed 2.95 ft. from the center of each of the two larger ones. In the grooves of the pulley *a* run 24 cords of a special steel wire, which alternate so that 12 of these cords pass over each of the main pullies. These steel cords are formed of two wires, each 2 millimetres in diameter, wound upon a core 3 millimetres in diameter, in such a manner as to make a rigid though flexible spiral cord of 5¼ millimetres in diameter. This system is very simple and strong, and the carriage upon which it was first placed has already made an aggregate run of more than 248,000 miles without any breakage.

MOTIVE FORCE.

There are three means of supplying electric energy to the car, viz.: (1) By primary piles carried in the car. (2) By conveying the power to a distance. (3) By carrying accumulators bearing the electric force.

(1) *Primary Piles.* Under existing circumstances this method must be rejected as it is not commercially practicable on account of the weight, space occupied and the delicate manipulation and other disadvantages.

(2) *Transport of Force.* To this system belongs a central generating station provided with its general motor and dynamos, and from which the electric force is conveyed to the car either by the rails themselves or by a special aerial or terrestrial conductor. If the transmission is by the rails the axles are isolated from the wheels and the motor receives the current from the dynamo generally by metallic brushes striking upon wheels which roll upon the conducting rail.

When the transmission is by aerial or underground

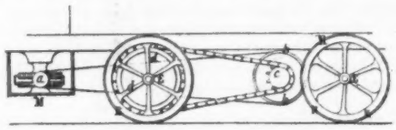

Fig. 2.—Transmission by Sprocket Wheel and Chain.

conductors, the latter being enclosed in a buried tube with an upper slot, a small chariot hugs the conductor in the tube, or runs on wires supported on poles; and by a flexible cable conveys the electric current to the car-motor.

This transport system, more generally applied at present than the accumulator system, works very well, but there is much waste of energy in the transport. The resistance of the conductors being generally great (2 ohms), it is necessary to employ currents of high tension, which during their passage may cause grave accidents; and these accidents frequently occur.

M. M. POLLOCK and BINSWANGER have devised a special and ingenious arrangement which seems to reduce the dangers above referred to. This is an isolated cable conductor, brought into action by a powerful magnet suspended under the car, with a third sectional and articulated rail. On the passage of the car the attraction between the third rail and the magnet establishes between the cable and the rail a temporary contact which ceases altogether when the vehicle has passed by.

Another inconvenience of the transport of force by conductors is the waste of power which increases with the distance from the central station. The longest line now operated on this system is that of Port Rush, in Ireland, about 5.9 miles in length.

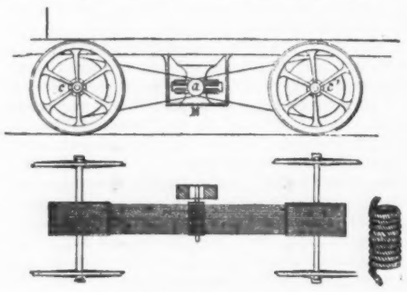

Fig. 3.—Transmission by Steel Cords, Pullies and Grooved Wheels.

(3).—*Accumulators.* This is the most seductive of all the systems proposed. By it the vehicle is rendered independent; it carries its own force within it to any desired distance according to the power stored. It is not tied to the bank, so to speak, by a wire or rail, for it may even leave the rail proper and still be self-moving. If the places in this car are not all taken the reduction in weight is a gain, for the car charged to run only 50 miles may possibly be transported twice that distance with the same reservoir of electric force. This mode of traction permits of a decrease in the length of the run by an increase in the normal velocity, and can command at will the extra power required for mounting grades.

Unhappily the gain in power means a gain in dead load, due to the accumulators, and there is a commercial limit in this direction. It is true that this disadvantage is not peculiar to electric traction; for any other system of mechanical traction, by steam or compressed air, is subject to the same fault.

In present experiments in this direction the batteries are disposed under the seats in the car or under the floor. To assure a force sufficient for a daily run of 48 to 60 miles for each car, it is necessary to arrange the batteries so that they can be readily replaced by new ones when emptied of their charge. And owing to their weight and the limited space in which to carry them, an electric capacity equivalent to 28 or 30 miles run is the practical limit. The battery of accumulators generally weighs about one-third of the total of the car the passengers and motor mechanism united in the case of a 30-mile run equipment. To supply 60 miles per day, the battery will equal in weight the whole useful load.

The only fault of this traction system is thus in the excessive weight required in the dead or non-paying load, or the weight of the lead accumulators which Messrs. JULIEN and RECKENZAUN employ. While they have attempted to reduce this load the results do not yet give complete or sufficient satisfaction. The "horse-hour" stored weighs more than 110 lbs. When this can be reduced to 40 or better to 20 lbs., the accumulator system will be commercially practicable. In present practice the accumulators are charged at the station by the use of a dynamo and then put in place upon the tramway; one battery is recharging while the other is in service.

EXISTING ELECTRIC TRACTION ENTERPRISES.

(1) *Transport of Electric Force—Elevated Railway (in New York)—Transmission by rail.* The experiments during the last two years on the Third Avenue Railway were on a line about 20,000 ft. long. Traction was secured by a locomotive of the Stephen & Field system, weighing 26,000 lbs.; of this 18,000 lbs. was in the motor. This engine draws 3 cars and 300 persons with a mean velocity of 7.8 miles per hour. The electric current from the generating dynamo was 40 amperes, with $E = 800$ volts; say, an electric energy of 32,000 watts-hour.

Electric Railway in Minneapolis, U. S.—Transmission by rail. This line is a little over 1 mile long. It was intended to replace a section of ordinary railway over which the authorities had forbidden the use of steam. Each train is made up of 3 or 4 cars, transporting 600 people, of a total weight of about 90 tons. The speed is 16¾ miles per hour with a motor of 40 horse-power.

Other American Lines. Besides these two lines there are more than 50 towns in the United States having electric railways of some kind. Without going into detail we will only note: Baltimore, with 1.88 miles; Los Angeles, 4.96 miles; Port Huron, 4.47 miles; Windsor, 3.1 miles; Detroit, 2.48 miles; Appleton, 2 miles, etc. All are in regular use; have been for some time; are upon the same model and give satisfactory results. The mean expense per car-mile is 6.4 to 8 cts.

Blackpool Railway. (England).—Transmission by conduit. This line is about 2 miles long. The rolling stock consists of various types of carriages containing 30 to 56 passengers. The initial electromotive force is 220 volts, which are reduced to 158 at the extremity of the line. The motor-engine is of 50 horse-power and the expense per car-mile is about 7½ cts.

Port Rush Railway. (Ireland).—Transmission by a third central rail. This line is 5.9 miles long. The generator at the central station is a hydraulic force of 100 horse-power. The dynamo-generator gives a current of 100 amperes with a tension of 250 volts. The motor-car will carry 50 passengers and haul 3 cars of freight.

Bessbrook Line. (Ireland).—Transmission by a third central rail. Here the main generating force is also hydraulic, supplying 62 horse-power to two dynamos, credited with 100 amperes and 250 volts. This railway does regular duty in the transport of passengers and merchandise. The average speed is 8.7 to 9.3 miles per hour upon an undulating route of 3 miles in length. The motor-car will carry 40 passengers and each of 3 wagons making up the goods train will carry 2 tons. In 1887, with 1,000 trains, the line transported 150,000 passengers and 1,500 tons of merchandise. The total expense of traction, including salaries, repairs, sinking-fund and motive force, is about 8 cts. per train-mile.

Brighton Tramway. (England).—Transmission by rail. This road has been in service since Aug. 2, 1884, and runs from Brighton to Kempton. The line has very steep grades and a total length of about 1 mile. The motor car carries 30 passenger and weighs 10,450 lbs. The average speed is 8 miles per hour. The service is very active in summer and almost nothing in winter. Last year it transported 200,000

passengers. The expense per train-mile does not exceed 6.4 cts. The central station has a gas engine of 12 H. P. driving a dynamo-generator giving a current of 20 amperes with $E = 160$ volts.

Moedling Line (near Vienna).—Aerial conductor. This line is 2.8 miles long. The line is one succession of grades and the difference in elevation between the extremities is 1180.8 ft. All the expense of motive power is in the ascent, as the train returns by gravity, controlled by powerful brakes. As at Brighton the important traffic is in summer. From April to November, 1887, it transported 350,000 passengers. The car weighs 8,800 lbs. net and carries 25 people; a total weight of about 12,760 lbs. The ascent is made in 16 minutes; or at the rate of about 10 miles per hour. The electrical station includes 3 engines of 12 H. P. and 6 dynamos, each giving a current of 30 amperes with a tension of 500 volts. The potential difference is 500 volts at the Moedling station to 290 volts at the summit of the line. The average expense is 6¾ cts. per mile run.

Frankfort Railway to Offenbach.—Aeriel conductor. The road has a regular service of 4.1 miles, with steep grades. Trips are made every 20 minutes; and the run is made in 40 minutes, 32 for traction and 8 minutes consumed in 8 stops. The line has been working since April 4, 1884. The expense is about 7¼ cts. per mile run. Each carriage with its dead load and passengers weighs 18,370 lbs. and carries 48 people. In 1887 it transported more than 1,000,000 passengers. The central station utilizes 2 engines of 60 H. P. and 4 dynamos giving each a current of 70 amperes with a tension of 300 volts.

Lichterfelde Railway (Berlin).—Transmission by rails. This is the oldest of all electric railways, having been opened on May 12, 1881, between Lichterfelde and the military school. The line is 1.5 miles long, and the carriage carries 24 passengers and weighs in all 10,560 lbs. It makes the run in 8 minutes at an average speed of 11 miles per hour. Each car makes 24 trips per day regularly; or, a total daily run of 36 miles. It carried over 100,000 passengers last year. The plant includes 2 steam engines of 6 H. P. and 2 Siemen's dynamos.

The author confines himself to the description of the above lines, as other existing lines are only copies of these.

TRACTION BY ACCUMULATORS.

Rochdale Railway (England).—This line is about 3.1 miles long, with steep grades (111.5 ft. difference of elevation). The carriage is very light, weighing only 4,400 lbs., and comprises in itself transmission, motor and brakes. The battery is made up of 80 accumulators weighing 39.61 lbs. each; or, about 3,300 lbs. for total weight of battery. The carriage capacity is 20 passengers of 156 lbs. each, so that the total weight to be hauled is about 5 tons.

The electric motor has a nominal power of 10 horses and weighs 594 lbs. This machine makes 1,000 revolutions per second, with a maximum current of 40 amperes and 160 volts. This velocity is reduced in the ratio of 10 to 1 by a transmission made by an intermediate axle and sprocket wheels and chains. A compensator is arranged to bring reserve power into action; so that in case of breaking away on a steep grade a force of 12 or 15 H. P. can be commanded.

Electric Tramways of Brussels. There are two lines here that have been in regular service for 2 years past. One runs from the Place Royal to the end of the *rue Beliard* and the other is in the *Parc au Rond-Point.* Each line is about 2¼ miles long and each car makes 12 round trips per day. The weight of one car and 30 passengers is 15,200 lbs. in total. The accumulators number 100 of the JULIEN system; and these are mounted either 100 in tension, or 50 in tension and 2 in quantity. There are two sets of accumulators so that they may be exchanged and each set has an electric energy capacity of 31 miles as a maximum. Each battery weighs 3,300 lbs. The station plant includes a main motor of 150 H. P. driving 4 dynamos, each giving 200 to 500 volts.

Hamburg Tramway.—This was built by the same company as that at Brussels and differs little from that one in detail. It runs from Rathhausmarkt to Bambek. As at Brussels the carriage complete, with 32 passengers, weighs 10,120 lbs. and the battery of 100 JULIEN elements weighs 3,300 lbs. The transmission of power is accomplished by belts, intermediate axle and sprocket wheels and chains. The speed of the motor is regular and varies with the manner of putting the accumulators in circuit. There are likewise two sets of batteries, each having a capacity of 31 miles. Each car runs about 62 miles in total per day.

Newcoves Tramway.—This line is 1.97 miles long, with gradients of 30 and 40 per cent. The motor car, which in case of need can haul a second lighter car, has a net weight of 6,160 lbs. The transmission is by the LICHTERFELDE system of steel cords; and this apparatus with the 10 horse-power motor weighs 1100 lbs. The car will carry 30 passengers. Each set of batteries weighs 3,300 lbs.; and the total weight to be hauled is about 14,000 lbs. The average speed of the car is 7.8 miles per hour. Each vehicle makes 10 round trips daily.

The following comparative table sums up the different typical lines:

(1) Traction of train by locomotive (New York and Minneapolis).
(2) " by transmission of force by cables (Frankfort).
(3) " " transmission by cables with steep grades (Moedling).
(4) " " transmission by rails (regular service) (Lichterfelde).
(5) " " transmission by rails (summer service) (Brighton).
(6) " " ROGER TATHAM accumulators (Rochdale).
(7) " " JULIEN accumulators (Brussels, Hamburg).
(8) " " GREEN " (Newcoves).
(9) " " Copper " (experimental on paper).

The author then gives an extended table comparing the transport of electric force and traction by accumulators. We give, however, only the author's summation of this table, as follows:

(1). *Traction by Transport of Force.* There is no sensible difference between the use as a conductor of the aerial cable or the rail. The work performed by the machine generating the initial force, with dynamos generating electricity, being assumed as 100, the loss by transmission of force from engine to dynamo is at least 30 per cent. The electric energy sent by the dynamo to the electric motor on the vehicle will be about $100 \times 0.70 = 70$; the loss by transport is about 40 per cent. With these two assumptions the motor will only then receive $70 \times 0.60 = 42$. The transformation of this electric energy into mechanical work will occasion a new loss of effect of at least 28 per cent.; and the driving wheels can thus only utilize 72 per cent. of the 42 available; or, say, 30.24 of the original 100.

To summarize the above it may be said that the driving wheels on the car only utilize on an average:

78 per cent. of the work furnished by the motor.
40 " " of that furnished by the generating dynamo.
30 " " only of the initial force from the main engine.

(2) *Traction by Accumulators.* Assuming as before 100 as the work done by the engine generating the initial force; the average loss in transmitting this force to the generating dynamo is 30 per cent. The energy furnished by the dynamo to the accumulators is then $100 \times 0.70 = 70$. The loss by transmission of the battery energy is 30 per cent. again, so that the motor can only dispose of $70 \times 0.70 = 49$. To transform this electrial energy into mechanical work will bring about as before a further loss of 28 per cent.; so that the useful mechanical effect upon the wheels is only $49 \times 0.72 = 35.28$ of the original 100. To summarize as before, we have:

The driving wheels can only on the average utilize:

72 per cent. of the electric energy furnished by the motor.
50.04 " of that furnished by the accumulators.
35.28 " of the initial force from the main generating engines.

It would thus appear that the economy of traction by accumulators over the transport of electric force is about 5 per cent. only.

A SMART citizen of Tennessee was in New York a few days ago to see about raising money for a proposed railroad line down in his country, and when asked to explain he said—

"There's no explanation about it. This is to be a railroad 200 miles long."

"But how about the company?"

"Oh, that's been organized and all the officers elected."

"What's the capital?"

"Fifty million dollars."

"How much stock has been taken?"

"About $300 worth."

"What, only $300 worth?"

"That's all mister, and if you fellows down here will pitch in and gobble up the rest of it, we'll go and make things hum."—*Texas Siftings.*

Plant and Machinery of the Panama Canal.

The following is an abstract of a most interesting paper upon "The Plant and Machinery of the Panama Canal," presented by Mr. WM. P. WILLIAMS, Jun. Mem. Am. Soc. C. E., at the last Annual Convention of the American Society of Civil Engineers:

Mr. WILLIAMS was personally upon the Isthmus last Spring under conditions favorable for the investigation of the methods and plant used on the Panama Canal, and he here details these observations for the benefit of American engineers, and to offset in a degree, reports that have their origin in employés who return broken down in health or those coming from disappointed contractors.

Instead of taking his notes from car windows, the writer traversed the whole line; by launch from Colon 15 miles, and then by foot and on horseback in such time as was necessary to fairly examine the work from Aspinwall to Panama. Four weeks were consumed in this examination. All the plant described was examined personally, and statements secured from engineers of the Panama Canal Co., contractors' engineers, foremen and intelligent workmen.

All plant is owned by the Canal Company and leased to the contractors at 8 per cent. per annum on its value. This is an expensive system for the company, as the contractors run them to their maximum capacity; spend little time on repairs, and side-track the machine when broken down, and make a requisition for a new one. Hundreds of expensive excavators, rock-drills, cranes, Belgian locomotives, were so seen, by Mr. WILLIAMS, side tracked and condemned for some minor defect. He says that the whole atmosphere surrounding the work is that of extravagance, and waste; and the prevailing opinion of the contractor seems to be—that as the climate is deadly the main end is to do the largest amount of work in the shortest time; make all the money possible, and leave the country to enjoy the proceeds in a more favored region.

During the early stages of work, plant ordered by the company, from France and Belgium, was not supplied fast enough, so the Canal Company agreed with different contractors to buy and furnish their own plant with a 15 per cent. commission paid by the company to the contractors "for their trouble." This, Mr. WILLIAMS says, accounts for the enormous amount of material on hand, purchasd by the contractors largely in excess of the demands for the sake of the liberal commission. Under the lock system very much of this is useless material.

The following description is restricted to the varieties of plant doing most satisfactory and economical work, and in some cases describing machinery that has not been intelligently used by the contractor:

The dredges used are the—American "Hercules" (Fig. 1); French Dredges (Fig. 2); Belgian Dredges (Fig. 3) and Scotch Dredges (Fig. 4). The American "Hercules" dredges are operated by the American Contracting & Dredging Company, of New York, and their work shows for itself along the Colon end of the line. They are the only firm of contractors that have successfully carried out their work on time. Their plant consists of 7 dredges, 4 with low towers and 3 with high towers. In noting the work done the "City of New York" is taken as an example. This dredge was located at Kilometre 14, deepening the canal channel from 15 ft. It was running 19 to 21 buckets per minute, three-quarters full, 3 buckets to the cubic metre. The material in the bucket exceeded the volume in the bank by 30 per cent. In 24 hours work the estimated excavation was 4,800 cu. metres.

The force on each dredge is put down as follows:

1 Captain	$300 per month.
3 Assistant Engineers	150 " "
2 Foremen	70 " "
3 Oilers	50 " "
3 Diggers	65 " "
3 Gypseymen	65 " "
1 Steward and 3 Cooks	75 " "
6 Waiter Boys	30 " "
30 Seamen and deck hands	50 " "

These men are divided into 3 watches of 8 hours each, and the machines are worked night and day. Sunday is devoted to replacing worn-out parts and general repairs. The average work relied upon is 100,000 cu. yds. per month. The "Dingler" dredge excavated 237,000 cu. yds. in one month; but it was dredging in loose material that had slid back into the canal, free from stumps and coral rock. The cost of the "Hercules" type of dredge has varied

from $100,000 to $120,000 complete at New York. The towage to Colon cost $5,000 for the first machine, and $3,250 for the last one sent down. The later dredges are much improved in detail on the earlier

Soft sticky clay; buckets not fully emptying at upper tumbler	3,000 to 4,000 cu. yds. per day.
Hard clay	4,000 " " " "
Sand	5,000 " " " "

on estimates given by the Company's engineer. At this price Mr. WILLIAMS thinks it safe to say that there was 100 per cent. profit, and notes the satisfactory work of this machine as an example of what

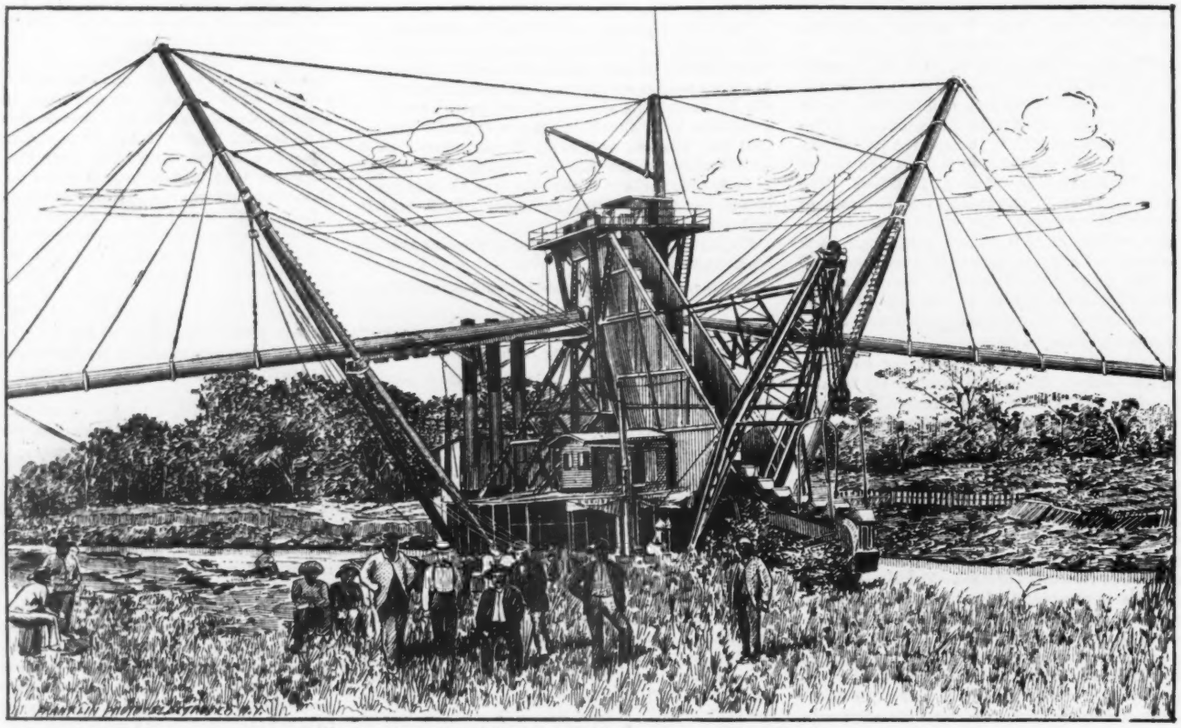

Fig. 1. American Hercules Dredge ; City of New York.

forms, and are now very effective machines. The high tower and long discharge pipe render them independent of the elements or manual labor, other than the force on the dredge. This is especially noted when the work of other dredging machines on the Isthmus is contrasted. The "Hercules" consumes about 10 tons of coal per day in doing average work; an expensive item that might be lessened by improved bridge-walls and boiler construction.

The estimate of work in various materials is given as follows:

(This estimate allows one day per week for repairs, and calls all days 24 working hours).

The estimate of cost of work embraces—first cost of dredge, towing and insurance to Colon, cost of erection complete, building and equipping a machine shop, duplicate machinery, maintenance of crew, hospital service, cost of New York and Colon offices, fence on bank to prevent sliding and levelling off top of bank under discharge pipe. Under the first contract with the American Contracting & Dredging Company, the price was 35 cts. per cu. metre on estimates given by the Company's engineer. At this price Mr. WILLIAMS thinks it safe to say that there was 100 per cent. profit, and notes the satisfactory work of this machine as an example of what would be accomplished by American contracting firms working in a tropical climate.

The Scotch Dredges.—(Fig. 4). These are self propelling and steamed from Scotland to Colon, and also to Panama around Cape Horn. They have boilers of 200 horse power and horizontal engines which operate a crank-shaft with sprocket wheel and belt. The upper tumbler-shaft has also a sprocket wheel and an endless chain belt running to the lower shaft. In heavy work the teeth on these sprockets break at frequent intervals. The long ladder being in one

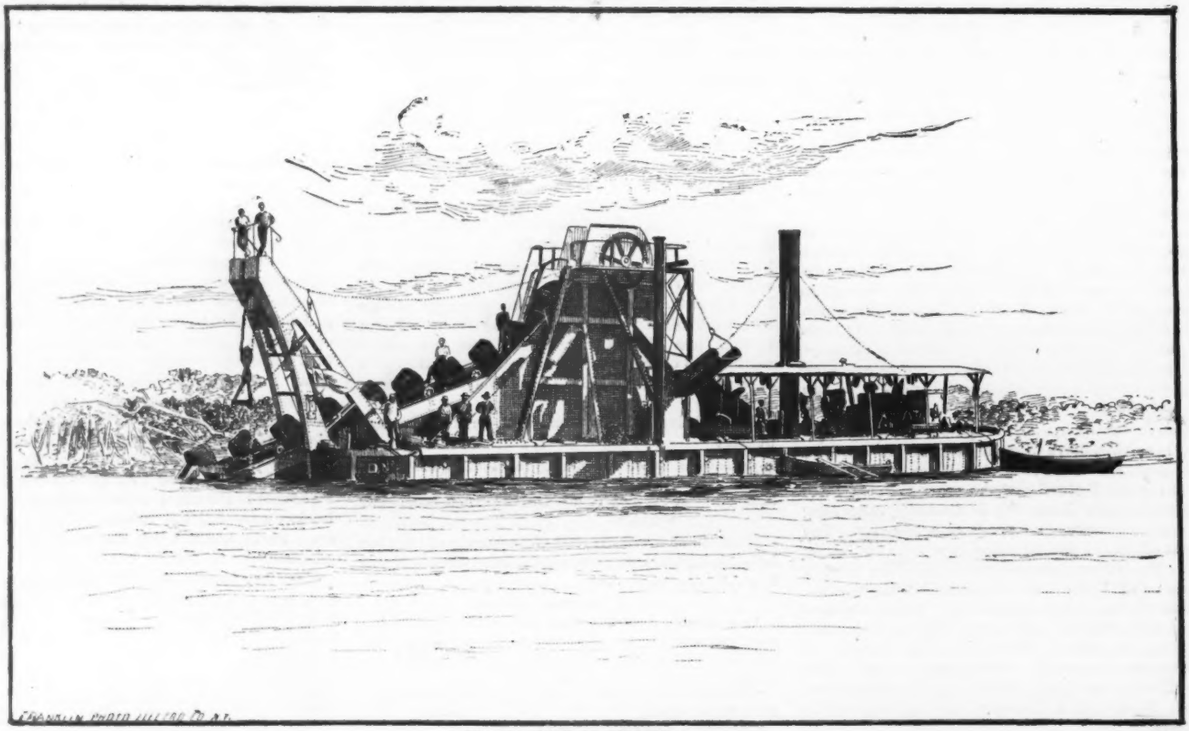

Fig. 3. Belgian Dredge.

section requires great dimensions to give the requisite strength. This dredge is better adapted to deep sea work than in a canal. It discharges its load by *clapets* and is manœuvered by fore and aft and side guys, instead of the single spud device of the "Hercules." Its draught is 7 to 8 ft. and the furnace consumes 6 tons of coal per 12 working hours. In material they can excavate 2,000 to 3,000 cu. metres in 12 hours.

French Dredge (Fig. 2). This is the principal dredge used along the line of the Panama canal. They differ in size, but the most common type is 100 ft. long by 30 ft. broad, drawing 7 ft. of water. The hull and all the machinery is of iron, built in sections in France and shipped first to Colon and then to points along the line. They cost approximately at Colon $110,000, not including cost of erection, which some engineers estimate added 35 per cent. to the original value. The hopper under the upper tumbler is only 20 ft. above the water level. The ladder is in one section; is supported upon an axis in the low tower, and is shifted in length to adapt it for use in various depths, etc. The buckets are of wrought-iron in one piece, the link being an integral part of the bucket. (The Hercules dredge has links bolted to the bucket-flange so that a broken link can be readily replaced.)

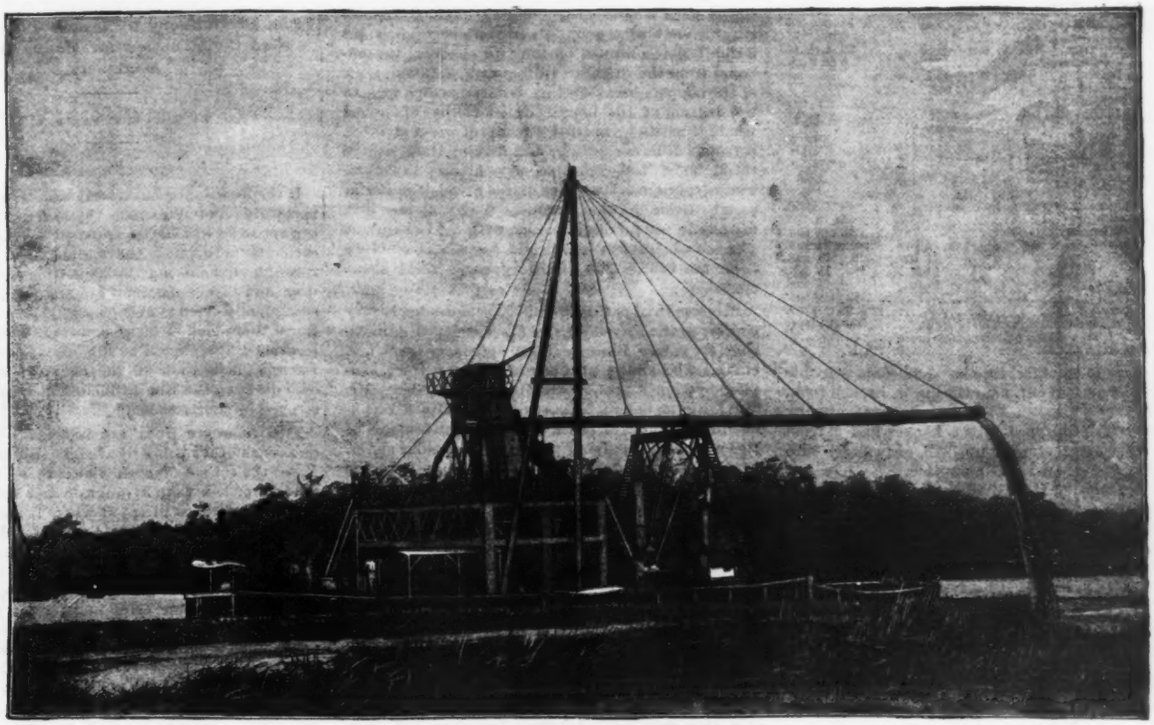

Fig. 2. French Dredge with Long Discharge Pipe.

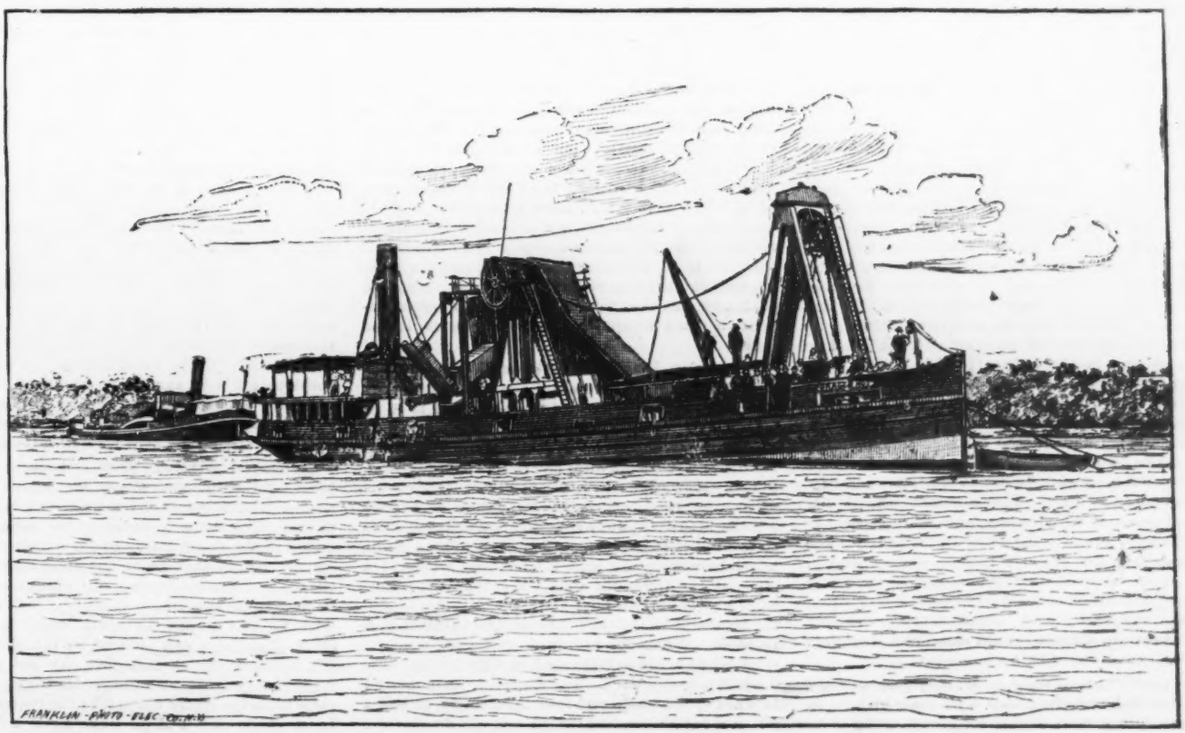

Fig. 4. Scotch Dredge.

3 Scotch dredges visited at Panama by Mr. WILLIAMS, the average output was only 200 cu. yds. per hour owing to coral rock encountered. In ordinary

The largest French dredge has the following dimensions:

Length	120 ft.
Beam	28 ft.
Depth amidships, underside of frames to top of deck beams	10 ft.
Draught in working trim	7 ft.
Depth to which dredge will work	28 ft.
Sheer, fore and aft.	10 in.
Rise of deck	6 in.
Height of top tumbler from water line	26 ft. 6 ins.
Width of bucket well	5 ft. 3 ins.
Frames, 4 in. × 3 in. × ⅜ in.; 2 ft. apart with reverse angle irons 3 × 3 × ⅜ ins. every alternate frame.	
Plates of bottom and bilge, near well	⅞ in.
" " " otherwise	⅜ "
" on sides	⅜ "
" on well	½ "
Deck beams	8 × ⅜ "
(With double angle-irons 2½ × 2½ × ⅜ in.)	
Floors, 12 × 4 ins. with angle irons 3 × 3 × ⅜ in.	
Length of bucket ladder c. to c. of pins	64 ft. 4 ins.
Diameter of pins	2⅞ in.
Capacity of buckets	16 cu. ft.
High pressure cylinder, diameter 17 ins., stroke	24 ins.
Low " " " 34 ins., "	24 ins.
Air-pump " " 10-in., "	15 ins.
Circulating pump " " 10-in., "	15 ins.
Boiler diameter	10 ft. 6 ins.
" Length	9 ft. 6 ins.
" Heating surface	900 sq. ft.
" Working pressure per square inch	80 lbs.
Cost at Colon	$115,000

One of the larger machines has done some valuable work at the Mindi cut, near Gatun, in broken rock, stiff clay and hard-pan. The material excavated by the buckets is dumped into a hopper and carried away by water, pumped up, and discharged into self-dumping steam scows alongside.

The capacity of these dredges is extremely variable, no one machine having done any large amount of satisfactory work. A fair average, with sufficient scows, is 200 to 250 cu. yds. per hour. At La Boca one of this type was timed at 20 buckets per minute with buckets half-full. It burns about 10 tons of coal per day and works a crew of 26 men; 16 sailors at $50 each per month and 10 men of the steam engineering staff. At these figures the cost of maintenance is about $188 per day, excluding breakages. A great number of skilled men are necessary to work the dredge satisfactorily, scattered over various parts of the boat.

This dredge received its power from the horizontal engines connecting with three vertical pistons, acting direct on the crank shaft located in the tower. Large balance wheels and gear wheels on either end of this shaft transmitted the power through three other lines of shafting to the upper tumbler. From repeated experiments this shafting was made strong enough to allow the dredge to accomplish satisfactory work in the hard material. The positive power thus attained was necessary in heavy work, the only objection being that as there was no safety point, in striking the more tenacious material in the lower strata, not having been broken up by blasting, the average capacity of the machine was passed and the machinery badly strained.

French dredges are also in use in which the power is applied through a sprocket wheel and chain; with the result that the teeth break frequently. At Tavernilla, on April 17, a French dredge was seen at work attacking a bank 30 ft. above water level, by undermining and thus breaking the mass. This dredge had 200 horse-power engines; the discharge of material was by water, breaking it up by two 8-in. streams of pumped water injected on the clay, etc., in the hopper; it then flowed overboard into a hopper-scow alongside. In this scow was a horizontal engine and boiler operating a centrifugal pump with a 14-in. discharge pipe. A vacuum being formed the disintegrated material was taken up by suction and discharged through a *corrugated* iron pipe, 14 ins. in diameter, and supported on pontoons. The material was finally landed on shore 600 ft. away, and 30 ft. above the pump and 45 ft. above the water in the canal. The engineers claim to so move 1,300 cu. metres per day. The disadvantage of this system is that the pump blades often break on the sticks and stones passing through the grating used. Again, a dredge running 20 buckets per minute would demand a discharge pipe 20 ins. instead of 14 ins. diameter.

The pontoons used were good; they consisted of 4 air-tight iron cylinders, each 5 ft. long by 3 ft. in diameter; they were rigidly connected at the sides by wooden X-braces and floated vertically. The discharge pipe was supported in these braces. Between the pontoons a 3 ft. flexible joint was made as follows:—A leather sleeve of the same diameter as the pipe was covered with strong copper wire cloth and the whole riveted to 14-in. flanges. With good and sufficiently thick leather this joint will stand a pressure of 100 to 120 lbs. per sq. in.

At Tavernilla, Mr. WILLIAMS saw under construction an auxiliary to the French dredge. This was an iron barge 60 ft. long by 30 ft. wide, containing in the stern 3 horizontal pumping engines. Amidships were built 2 hoppers with large cylinders and a small bottle-necked opening for receiving the material from the dredge. Iron gratings in the neck of the hoppers break up this material, which falls to the bottom of the hopper outlet (20 in. diameter) where it meets 3 powerful streams of water striking it from 3 different points, and driving it out ashore through the discharge pipe, on pontoons as before. The advantage is that none of the dredged material passes through the pumps. This is the best method in use for high banks, with a discharge at some considerable vertical and horizontal distance from the boat. This auxiliary barge costs about $20,000.

Belgian Dredge, Fig. 3. This type of dredge is very similar to the French dredge described, communicating its power likewise from sprocket wheel and chain. The 2 horizontal engines are 200 H. P., supplied by 3 horizontal, return flue tubular boilers. Mr. WILLIAMS as before points to the liability of breakage in the sprocket teeth, and the disadvantage of this method of applying power to the dredge chain. The Belgian dredges are less in tonnage than the French, and consequently cost about $90,000, not including cost of erection at Colon. The complement of men runs from 30 to 40, arranged, as in the French and Scotch dredges as well, to work in one watch, viz: during the daytime only. Night-work is not attempted, owing to the liability of the dump-scows to run aground in the darkness.

Rock-Drill.—A large consignment of the Ingersoll type of rock-drills were sent down to the *Société des Travaux Publics*, for use at Bas Obispo and at Emperador. But owing to an insufficient number of skilled foremen to instruct the native workmen, they were worked only a few days and then the whole plant was abandoned. Mr. WILLIAMS did not see any machine drills at work on the whole line, and says that the modern plant which has accomplished such wonders on the New York Aqueduct was side-tracked at Panama for the lack of instructed labor only.

French Machine Drill. This is a cumbersome appliance on uneven ground, and in almost any class of work. A platform car on 4 wheels carries a horizontal boiler of 15 horse power and an upright frame on which work 4 drills 3 ft. apart, raised and lowered by a ratchet and pinion attachment on the frame. A shaft from the main engine turns the drill by means of beveled wheels in such manner that the drill bores rather than strikes a direct blow; and the drill is held to its work by the hand of the foreman of the machine. A 5 ft. track is required over the area to be operated upon, and a number of holes are first drilled to the required depth. The machine is then run back, *the track is removed*, and the holes charged and fired by electricity. As any American contractor can realize, this method is clumsy and expensive when compared with the systems in use here.

Submarine Rock-Drill.—This drill has been successfully used on both ends of the line, and at Fox river at Colon. The hull of the boat used is 50 ft. long by 20 ft. broad, and it carries an engine which can be shifted either on to a propelling screw or on to the drills. In the forward end of this boat is a well, 15 ft. by 20 ft., over which a "traveller" supports the drills. An extension shaft, by means of beveled wheels, transfers power from the main engine shaft to the top of the frame, and these to the 4 drills which bore their way into the rock, by means of a screw at the top of the drill. A telescopic water-tight pipe is lowered from the frame and driven into the bottom material, and through this the drill does its work. When the hole is deep enough, the drill is withdrawn, the hole charged, and the battery wire made fast to the deck. The frame is then moved forward on its track and four more holes drilled a few feet further on, and loaded and wired as before. When a sufficient number of holes are thus prepared the boat is moved to a safe distance, and the holes are fired. The coral rock thus broken up is then attacked by the dredgers and removed. This method is noted as seeming both successful and economical in deep sea mining operations. The hull of the boat costs from $3,000 to $5,000, and the entire plant about $2,000 more.

TO BE CONTINUED.

From Preliminary to Track—Points in Railroad Construction for Young Assistant Engineers.

BY MILNOR P. PARET. C. E.

(*Continued from page 106*)

If the location be but a trial one, it will rarely be necessary to reference more than a few points, such as are apt to be lost in the course of a year. If the location be permanent, the line should be referenced throughout, as it may be some time before right of way and other matters are settled and the construction started; and possibly an entirely different corps may be on that work. In a permanent location *P. P's*, should be run out whenever possible. In referencing, all of the *R. P's* should be far enough from the line to insure their not being destroyed by construction.

Two reference lines are sufficient; they should cross each other as nearly at right angles as possible. Note the course of each line; there should be 4 (and never less than 3) plugs on each line, 2 on each side. A reference plug put where it may be plowed up or otherwise lost is time wasted and worse. Set an outside plug on each line from the instrument on the center line, and then set the other plugs on the reference lines from these by foresight. It obviates possible error in reversing the transit, and insures your seeing from one *R. P.* to another, which might be overlooked in case they were all set from the center line. Consider the profile in setting *R. P's*, a high fill may come in between them. Note also the distance out to the various plugs. Enter in the field books the names and positions of members of the party and the date when you begin and end a day's work. Note in the fly leaf of the transit book that all plugs on conter line are, say to the left of, and 14 ins. from the marker, and that *R. P.* plugs are south, and 14 ins. from the marker, but do not neglect to make them so in the field.

In connection with the location proper there will likely be many small surveys of towns, farms or other properties, county, State, township, or section, lines run out, and deeds and records must often be hunted up and consulted. Much of such work is done for right of way purposes. There are instances of the right of way agent (who may or may not be an engineer, generally may not) going over the line and buying most of the right of way from a profile. This is the worst kind of practice. There is no better way than for the locating engineer to submit right of way plans to the chief engineer, showing on them distinctly all the directly affected topography and proposed widths to be purchased; these widths can then be modified by the chief after consultation with the right of way agent as circumstances, emergencies or policy may dictate. Right here it may well be remarked that in all railroad construction work there is no more fruitful source of future expense, annoyance, law suits and general loss of religion than inadequate right of way and carelessly and poorly kept records of the same.

On general principles 30 ft. and slopes for single track and 60 ft. and slopes for double track is ample. This is a sort of standard with many roads, though often for a second track or siding 12 ft. is added to the single track width. "Thirty feet and slopes" means that where the grade coincides with the natural ground surface, the width taken would be 30 ft., and that where there is a 20-ft. cut or fill with 1½ to 1 slopes, the width would be 90 ft. or 30 ft. plus the width covered by the slopes 30 ft. (1½ times 20 ft.) on each side. Do not do as the right of way agent with the profile might, figure the slope from the center cut or fill; the center line may be at grade and a slope stake show a cut or fill of 15 or 20 ft. In case a parallel width or strip is taken through a property, the right of way map should bear the same detail and the deed the same sort of description as if the whole property were purchased. A piece of property with an actual lo-

cation is to be bought, and not a strip parallel to an indefinitely described line.

If at any time during the location work there should be very heavy rains, causing freshets or floods, go over the line at time of highwater and set stakes at highwater mark, on each side if possible, of all streams crossed by the line. Later after the streams have subsided go out with level and rod and take cross-sections at all these points. Two or three cross sections should be taken of every stream no matter how large or small. They should generally be taken just above where the line crosses and always where the channel is well defined. And not where exceptionally large sections are formed by back water from drift-wood or a bend in the stream or other obstruction to the free flow of water. Such cross-sections plotted and their areas calculated form not only an interesting study but an excellent guide in determining the size of openings.

Observe carefully and note all features which may in any way indicate the probable classification of the grading, such as out-cropping rock, artesian wells, quarries, cuts of adjacent railroad or public roads, the banks of streams, etc. Note the size of openings for streams under other adjacent highways; they determine in a great measure the size of those to be built in connection with the new railroad. Walk to the sources of the smaller streams if that point be within 5 or 6 miles; the size of openings may have to be determined from area of surface drained using one of the various formulas for that purpose; it is well to look at such subjects in every possible light.

To relieve the chief, the assistant engineer will have a detailed estimate of cost to make up. This may mean only grading, or it may include the small pieces of masonry, or possibly the grading and all the masonry, iron bridges of small span, ordinary overhead bridges of small span, wooden trestles, etc. Such matters as right of way, track, telegraph line, sidings, yards, turn tables, water tanks, stations, signals, large bridges, incidentals, contingencies and so forth, are the province of the chief engineer and over which the assistant in the field will not have to exercise himself; indeed he will be fortunate if he has more than the grading to estimate on. But we will suppose that he is to estimate according to the last case mentioned above. Ask the chief for a list of the overhead and undergrade crossings agreed upon by deed or settlement with property owners. You may make an undergrade crossing do for a water course as well, and some right of way agents have an unpleasant way of promising property owners undergrade crossings at unnecessary and uncertain points, and so spend $5,000 or $10,000 that he may save $50 or $100 an acre on 2 or 3 acres of land.

The general rate of grades will be obtained from the projected profile of a paper location, these will be modified of course; in case you don't estimate until the line is finished or well toward the end, the chief engineer will fix the grades; he will be certain to revise those laid down by the assistant engineer.

A "Henck", "Trautwine" and "Morris on Earth-works", are all the books necessary in getting up an ordinary estimate. Divide the line up in sections of 5,000 or 6,000 ft. each, in such a manner as will balance cuts and fills so nearly as may be estimated from a glance at the profile. Take from the profile the center heights and use generally level cuttings with the proper slopes, but watch for side hill work when it would be well to plot rough cross-sections picked from the contours. Work out the cuts and fills as they come in succession on the line, separately and from grade point to grade point. Have a tabular form for this work showing the areas and yardage station by station; show the classification in red ink as you estimate it at the end of each cut; 5 columns are sufficient for the estimate sheet; one for stations and pluses, one for center cut or fill, one for cross-section area, cut or fill, one for mean area by distance between them, and one for cubic yards.

Make a summary sheet showing the quantities cut by cut, and fill by fill, for the section. Balance the cuts and fills, consulting the profile and noting that so much of the cut goes one way and so much another and remember that it may be cheaper to use surplus material in fill for second track or siding room, and borrow again, than to haul a couple of miles or so to make a light fill. Consider a yard of excavation as making a yard of embankment unless the cut be largely rock which will swell considerably in bank. Do not deduct from the fills the area occupied by arches and small bridges; it is inconsiderable. Then there are such items of excavation as for foundations, grade crossings, changes of roads and stream channels, berm and side ditches, which may appear small individually, but collectively very seriously affect the cost of the section. It is not safe to consider any such excavation as available for embankment unless some one item is considerable, say 1,000 yards or more. In the country nearly every farmer must have a grade crossing, and in towns the grades of streets may have to be changed materially; it is expensive work, and should be classified liberally. Some foundations requiring coffer-dams, shoring up, sheet piling, and pumping, are very expensive and are generally covered by extra bills allowed the contractor or by some item in the contracts as "wet excavations"; the latter is the better practice.

Such masonry as arches, abutments, retaining walls, piers, etc., *can* be estimated from Trautwine's tables and rules, but it is better to make rough sketches of each piece of masonry, giving the approximate dimensions and figure from these. Use a heavy cross-section in estimating for abutments and retaining walls; arches may be lighter. It is well to have arches a foot longer than the exact cross section would call for. Of course there will be considerable classification in the masonry, depending on the importance and locality of the structure. If not the best practice it is certainly a very good one to call of one class *all* the masonry in an individual structure, foundation, neat work backing, etc., except paving, which is not masonry proper.

The Location party should find time to take borings and soundings at masonry sites, with view of determining the nature of material on which to found. If estimating for timber foundation use two courses of say 10 × 10 timber, laid close up. If piles are used the length may have to be guessed at; in estimating piles 3 ft. apart, will, if driven to firm bearing, carry about all the weight that could be put on them; a grillage of 10 or 12 in. square stuff must go on top of these. A good way to estimate wooden trestles, is to take an average height of bent, calculate the feet *B. M.* in one span say of 12 or 15 feet, and so the total *B. M.* in the whole trestle. The pieces which go to make up a trestle of about the above span and say 15 to 25 feet high, are generally about as follows: caps and sills 12×12, plumb posts 12×12, batter posts (batter 2 or 3 ins. to foot) 10×12, cross braces of 3×10, stringers (2) 8×16 under each rail, longitudinal brace 3×6 one each side about half way down and on outside of batter post, ties 7×10 and 20 in. *C.* to *C.*, guard rail on each side of 7×8. Should the height be near 25 ft. count on a W. brace of 7×9 going from cap of one bent to sill of next, thence to cap of next, beginning and ending with a cap.

If the trestle is to be permanent, the footings should be of masonry, carried high enough to keep the sill dry, and some 3 and 4-in. stuff for blocking, separators, etc. Ordinary wooden overhead bridges for country roads are generally of the king or queen post truss style on trestle bents with masonry footings; beside the truss there are the floor beams; the floor which should be double, the guard rail, the hand railing and the trestle bents figure the approximate feet B. M.

The masonry sheet need not contain anything more than results; that is the size of the different openings and the yardage. It is well, however, to keep one rough copy of the calculations as they are convenient for reference on construction particularly should the estimate be found to over or under run on any particular structure. The following table gives the cost of some iron railroad bridges of the shorter spans. It is the actual cost of some bridges built by the Pennsylvania Railroad, on some of their last new lines which were designed to carry their heaviest traffic. The costs are given of each of these particular bridges, but it is not meant that other bridges of the same span must have the same approximate cost, there are entirely too many variable quantities in bridge construction, such as price of labor and iron, live load assumed, necessarily lessened depth of truss, delivery of material, etc., etc., ever to warrant any such statement. Iron was at 4 or 5 cts. per lb. erected.

Length	Character.	Cost.	
15 ft. cent. span	Deck Girder.	$ 175	$ 225
20 " "	" "	350	400
30 " 0 to 0	" "	500	550
40 " "	" "	800	850
50 " cent. span	" "	1250	1350
74 " "	" "	2800	3100
76 " "	" "	3800	4000
74 " "	Sthrough "	3900	4100
100 " 0 to 0	Through truss.	5400	6000
125 " "	" "	7000	900
150 " "	" "	11000	12000
167 " "	" "	12000	13000
175 " "	" "	12000	14000

It is useful in estimating masonry to know roughly that deck girders are about as deep in inches as they are long in feet and are from 5 ft. to 6 ft. 6 ins. c. to c. One-half through girders, about 2 ft. from *B. S.* to base of rail and 12 to 14 ft. c. to c. Deck trusses are from 30 ft. deep for 100 ft. span to 45 ft. deep for 300 ft. span (but these depths vary greatly) The chords are about 9 ft. c. to c. Through trusses are about 3 ft. from *B. S.* to base of rail and are 14 to 16 ft. c. to c. chords for single track and from 28 to 30 ft. c. to c. chords for double track. Estimated prices for the various kinds of work can be obtained from the Chief Engineer or in fact from the current engineering publications somewhat modified to suit transportation of material, proximity of good stone quarries, etc.; the limits will very likely run somewhat as follows:

Earth excavation per yd	.15	.30
Loose rock or hard pan excavation per yd.	.35	.50
Solid rock, " " "	.70	$1.50
Wet or foundation, " " "	$1.00	2.00
Borrowed embankment, " "	.20	.50
Tunnel, " " "	3.00	8.00
1st cl. bridge or arch masonry, " "	8.50	12.50
2d " " " " " "	7.00	9.00
3d " " " " " "	5.00	7.00
Dry masonry, " "	3.00	5.00
Paving, " "	2.00	4.00
Riprap, " "	1.00	2.00
Timber in foundation per M. ft.	20.00	40.00
Iron " " "	.03	.70
Piling in found or trestle per lin. ft.	.30	.50
Timber in trestles and small bridge erected per M	35.00	45.00

It is well to turn in to the Chief Engineer, beside the detailed estimate sheets, an estimate profile which will show at a glance the work to be done and its location. This profile should have all the information of the regular profile previously referred to, and in addition, the section marks; also let each cut show the yardage and classification and each embankment the yardage at their proper location, the various bridges and the other openings, their size, yardage of excavation and masonry classified, grade crossings overhead bridges ,change of roads or channels, etc., etc. Then in some roomy place make a summary somewhat after this form:

SUMMARY OF QUANTITIES.

Section 4, *Length* 5,500 *ft.*

35,000 yds. earth excavation.
12,000 " loose rock "
8,000 " solid " "
3,500 " wet "
3,000 " 1st class masonry
1,800 " 2d "
750 " 3d "
220 " dry "
120 " paving
30,000 ft. B. M. timber in foundations
18,000 lin. ft. piling
2,000 yds. sub-ballast

Iron Bridges:
one 20-ft. deck girder
two 50-ft. " "
one 125 ft. " through truss

This will complete the estimate work and give a very interesting profile to go in to the head office in connection with other reports and information To get these estimates, etc., in and at the same time keep the regular field and other work, will require plenty of night work. The writer recalls and not unpleasantly, late hours every night (except Saturday —an engineer corps may work on Sunday, but the assistant engineer who either works himself or makes his men work on Saturday night is not a true Christian), and occasionally an all night session with a couple of picked men. Never under-estimate on any work, the lot of the engineer who has to build a road on an estimate cost of $40,000 per

mile, but which will really cost $50,000 per mile, is not a happy one. Only older men, chief engineers with established positions and reputations can under estimate, for diplomatic reasons, and with apparent impunity.

The assistant engineer will do well to keep a check copy of all notes, maps, or other information of any sort which may leave his office for headquarters. We can now take up the construction.

(TO BE CONTINUED).

Notes on Warming Railroad Cars by Steam.*

In this paper Mr. W. J. BALDWIN, described a series of experiments, made on the Long Island Railroad, December 1887, for the purpose of determining the amount of steam required to heat a car, and also the time Gold's storage car heater would

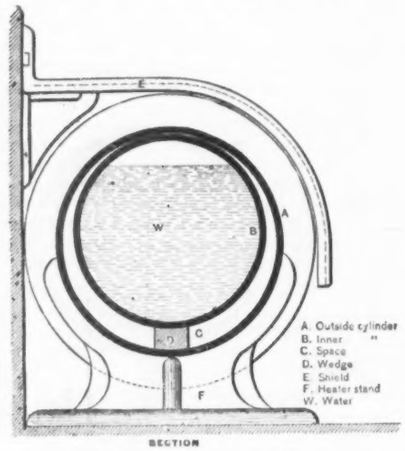

Fig. 1. Gold Storage Car Heater.

maintain the temperature of the car after steam was shut off.

The Gold Storage car heater is shown in section in Fig. 1, as applied to car 190 of the Long Island Railroad. *A* is a 5-in. diameter boiler tube of any required length (18 or 20 ft.) with a cap on each end; *B* is a similar tube 4¼ ins. in diameter with welded ends, ⅝ filled with water and a solution of common salt; *C* is a steam space between the outer and inner tubes; *D* is a block of iron to hold the inner cylinder against the internal top of the outer cylinder; *E* a shield and foot-guard, and *F* a cast-iron stand or leg fastened to floor of car. Each .764 running foot of the warming cylinders has one square foot of heating surface; one running foot of length of cylinder has 1.309 sq. ft. of surface; a running foot of the inside cylinder contains 7.393 lbs. of water, when ⅞ full; one running foot of the inside cylinder and one running foot of the outside cylinder weigh together 13.4 lbs.; and, assuming that the water is put into the cylinders at 62° F., the iron of both cylinders has a storage capacity equal to 1.5347 lbs. of water at 62°, and a running foot of the heater (including cylinders and water) has a heat storage capacity equal to 8.8277 lbs. of water.

The manipulation and operation of the heaters is as follows: Steam is admitted to the space *C* the same as to any radiator. The heat of the steam is at once apparent in the car through the wall of the outer cylinder *A*, while at the same time it commences to heat the water in the inner cylinder. When the steam is on for a sufficient time, the water in the inner cylinder becomes practically as hot as the steam itself, and remains so until the supply of steam is cut-off, when it begins to give off its heat by radiation, etc., to the walls of the outer cylinder.

In the diagram, Fig. 2, Mr. BALDWIN supplements the diagram with the following remarks. The line of figures at the bottom reading from left to right shows the time. The line of figures at the left reading upward shows the temperatures in degrees F. The ordinates of the lower irregular line show the temperature of the air outside the car. The ordinates of the next two lines show the temperature maintained inside the car by two thermometers placed at different positions and the ordinates of the upper two lines show the temperatures of the surface of the outside cylinders. The points at which steam was turned on and shut off are noted and the amount of steam, in pounds weight, condensed, as found by the water condensed, is also shown.

"When steam was first turned on, it was unsatisfactory and low, the pressure being but 10 lbs., at the regulator. It gradually increased however, to 25 lbs. at the regulator and 23 lbs. at the gauge within the car. At 10 A. M., the steam was shut off and remained so for 3 hours or until 1 P. M. The whole steam condensed for this time (4½ hours) was 180 lbs., which was condensed between 8.45 and 10 A. M. or 42.35 lbs. per hour.

"During the first hour and a quarter the car was warmed from 27° F. to 61° F. After steam was shut off the temperature of the car advanced about 1°. Then its rate of cooling was about 2° per hour.

"At 1 P. M. steam was turned on again and kept on for twenty minutes. The condensation was 67½ lbs., and it restored the heat to the cylinders for 3 hours longer or until 4 P. M., and sent the temperature of the car up to 69° F. This required less than 23 lbs. weight of steam per hour to maintain the heat of the car for the time.

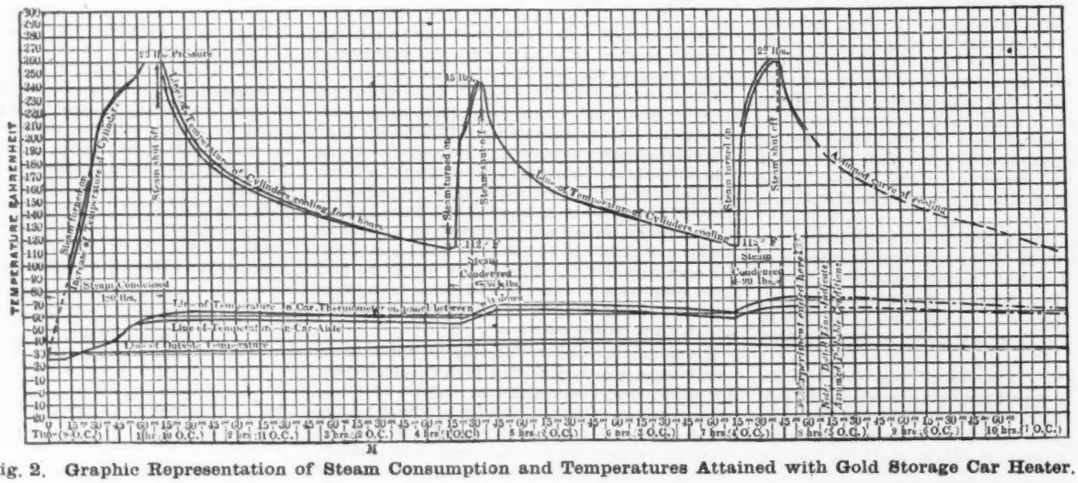

Fig. 2. Graphic Representation of Steam Consumption and Temperatures Attained with Gold Storage Car Heater.

"Steam was turned on again at 4 P. M. and kept on for 30 minutes. The condensation was then 90 lbs., and it is reasonable to assume it would have kept the car warm for 4 hours from the time of turning on. This is an average of 33 lbs. of steam per hour for *all day* or say one *horse power* per car per hour.

"The deductions to be drawn from the experiment in general are [1] that 2 sq. ft. of surface per running foot of car is more than ample for warming. [2] That each square foot of surface requires heat equivalent to about 2 heat units for each degree the air is colder than the heater."

A LOCOMOTIVE on the Central Railroad of New Jersey is said to have drawn recently a train of 16 passenger cars, upon which there were more than 1,000 people, a distance of 45 miles in 77 minutes, with a detention at a draw bridge of 6 minutes.

EMPLOYES on Swedish railways numbered, at the end of 1887, 10,924, or an average of 2½ per mile.

Rapid Railway Embankment Construction.

A very interesting account of the completion of a big fill in a very limited amount of time is given by ISAAC A. SMITH, Eng. Club, St. Louis, in the *Journal of the Association of Engineering Societies* for March.

A certain railway corporation in the city of St. Louis was permitted to extend its lines over and under various streets upon certain conditions, one of which was that "Hall Street was to be filled to the established grade and a width of 40 ft. within one year". Certain obstacles prevented the beginning of this work until all but twenty days of the allotted time had expired. The length of the required embankment was 1¼ miles, and the total amount of material required for it was about 95,500 cu. yds., all of which had to be obtained from points outside the street, upon which there was no cutting. Before the company decided to do the work themselves, bids from prominent contractors were solicited, to be accompanied by guarantees that the work would be completed within the specified time. No contractor would give such a guarantee, and the lowest bid on the work was 35 cts. per cubic yard.

The company concluded to do the work, and secured two borrowing pits near the middle of the fill, making the average length of haul about 1,300 ft. The material was wholly silt, the pits being situated on the west bank of the Mississippi. Mr. SMITH describes the details of the work as follows:

The first work performed was that of building a road from the borrowing pits to the embankment. This was done by cutting down the willows which grew over the borrowing pit, and between it and the street upon which the embankment was to be constructed, and laying them crosswise of the road and putting dirt upon them to hold them down, the road of course being simply a temporary one for use during the time of construction. After clearing all of the logs, stumps and other debris from the surface of the pits, which required two days, on the morning of the third day the work of constructing the embankment began. Sixty two-horse wagons were placed in service for each pit, making one hundred and twenty in all. A space was opened in each pit of sufficient width to load twenty wagons at one time, and seven men were detailed for each wagon, making one hundred and forty men, exclusive of a foreman, in each pit.

After the wagons were loaded they were driven straight forward, without turning, to another road already constructed, and following this road conveyed their loads to the place of deposit. When the wagon reached the dump it was driven to a place designated by the dumpman. If by any accident or fault of the driver or horses the load was stopped short of the point designated it was at once unloaded, for the orders were strict against permitting teams to pull a second time on a load after it was stopped on the soft dump. The wagon, after being unloaded, proceeded over the forward end of the dump to the road in the pit. A ticket boy, provided with a sufficient number of tickets, all alike, handed one to the driver of the wagon as he passed going to the pit. Drivers were required to exhibit forty of these tickets for a day's work. The tickets were returned to the time-keeper every evening.

There was one walking foreman in each pit, whose business it was to preserve order among the men, a direct where the wagons were to be loaded. The men were not allowed to speak to each other, neither were

*Abstract of paper, read at Seventeenth Meeting Am. Soc. Mech. Engineers.

they allowed to smoke or drink. Teamsters were not allowed to leave their seat upon the wagons. Men were employed, who carried water and watered the horses when they needed it. Ice water was carried to the men when it was needed. If a man was derelict in his duties, or was falling behind in the performance of what was expected of him, the foreman would warn him first that he must do better. If a second warning was necessary it came in the shape of a discharge, the foreman being provided with a pad of blank discharges requiring a very small amount of writing, one of which he made out and handed to the discharged employé, who conveyed it to the time-keeper, and from the time-keeper he received a check on the treasurer for his money, his number being preserved after he was discharged, and a remark made opposite the number in the time-keeper's book stating the cause of his discharge. If the cause was not through any fault of his own, if it was from sickness of himself or family, or from any cause that he could not control, there was no objection to his being re-employed; but if his discharge was occasioned by any fault of his own, he was not re-employed. Each pit foreman was provided with a staff 8 ft. long with notches cut in it, by which the wagons were measured. The required dimensions were 8 ft. long, 3¼ ft. wide and 20 ins. deep, and no wagons not up to these dimensions, were allowed on the work. The wages paid to teamsters were $4 per day; to walking foremen, $2.50 per day; time-keepers, $2.50 per day; dumpmen and shovelers, $1.50 per day; ticket boys $1 per day.

The second pit was operated precisely as has been described for the first one. However, all of the material required for the embankment did not come from these two pits. There were some cellars being dug in the vicinity and some street reconstruction; from both of these sources some material was obtained, it being hauled to the dump by the contractors for these respective works. A separate system was observed for this character of work. The teamsters were each given a ticket for a load. The tickets were printed and were numbered serially, and each of them contained the autograph signature of the chief engineer. This was done to prevent counterfeiting. These tickets were redeemed at the office of the company in quantities exceeding ten, and ten cents apiece was generally paid for them. The wagons which conveyed this outside material to dump were of different sizes. Some of them would contain more than a yard and some less. In sixteen days from the time the work began it was finished forty feet wide to the established grade; that is to say within a period of sixteen days 97,500 cubic yards of material was deposited on this embankment which was about 10 ft. high, 40 ft. wide on top and 1¼ miles long.

Generally, when work is rushed through as this was, little attention is paid to economy; but in this case every detail was watched closely so as to reduce the expenses to a minimum, with the result that the cost of the work per cubic yard was 18.58 cts., or just about half the lowest price asked by a contractor, and that without a guarantee. The remarkable success attained was due to the excellent material used, fine weather throughout, and to thorough organization.

Automatic Regulator for Heating Apparatus.*

In this paper Mr G. T. HAWKINS first points out the advantages of hot water over steam for heating purposes, the principal one being that the temperature of the water may be regulated to suit the season while the only means of regulating heat from steam is by shutting off the supply, thus necessitating a series of fluctuations from low to high temperature, and the reverse. In the open hot water circulating system any temperature of water below 212° Fahr. may be maintained, while steam radiators, if heated at all, must be kept at or above 212°.

The author then speaks of the automatic electric regulators for hot-water and hot-air furnaces governed by the temperature of the apartment by means of a delicate thermostat making and breaking electric currents. These arrangements can only be operated by extremes of temperature, and the result is a succession of alternate hot and cold periods incompatible with comfort.

Mr. HAWKINS then described an apparatus devised by himself which can be made to depend upon the temperature of either a supply or a delivery pipe. It consists of a helical thermostat surrounding a supply or delivery pipe, as preferred, which is connected with the door of the ash pit by means of a chain passing over guide pulleys. A counterbalancing weight enables the door to be opened or shut by a very slight force. The lower end of the helix is attached to a lever arm which may be rigidly fastened by a pin thrust through any one of a number of holes, thus furnishing a means of adjusting readily the action of the thermostat to the requirements of the occasion. The thermostat consists of two strips of metal, having very unequal coefficients of expansion. The most expansible metal is put inside, where the fluctuations of temperature will be greatest, while the outer and less expansible one well be exposed to the air and only slightly affected by the temperature of the pipe. In this way a much greater straightening or unwinding results from a given change of temperature, than if the thermostat were wholly subjected to the same influences. In this way a considerable motion of the free end of the helix is obtained for a very slight change of temperature of pipe. The adjustment is made for any desired temperature of apartment, and thereafter the apparatus maintains this temperature. The device can be made adjustable from any apartment if desired and can be modified to suit almost any conditions and is equally applicable to hot water and hot air heating systems.

*Abstract of Paper presented at Seventeenth Meeting, Am. Soc. Mech. Engineers.

The Weather of the United States for the Month of July, 1888.

[As respects the elements of most interest to engineers.]

According to special returns from the Chief Signal Officer of the U. S. Army.

STATION.	Temperature, Degrees Fah.				Wind Velocity.			Precipitation, Rain and melted snow. Inches.		
					Miles per hour.		Direction.			
	Average	Max.	Min.	Range.	Average	Max.	Max.	Total.	Heaviest in 24 hours.	No. rain days.
Northern Cities.										
Northfield, Vt.	63.2	85.	40.7	44.3	8.1	38	SW	1.30	1.04	12
Portland, Me.	65.5	87.1	50.5	36.6	5.9	35	W	1.90	0.67	13
New York City.	70.3	81.5	63.5	18.0	6.2	48	NW	1.27	0.39	8
Pittsburg, Pa.	71.7	90.3	50.5	39.8	5.1	25	W	4.36	1.10	11
Chicago, Ill.	72.0	94.3	56.3	38.0	8.7	39	NE	3.93	1.29	11
Omaha, Neb.	77.6	101.2	60.	41.2	7.0	37	NW	2.56	1.26	9
St. Paul, Minn.	72.0	94.	55.5	38.5	3.8	36	W	5.55	2.06	12
Duluth, Minn.	63.2	88.7	45.2	43.5	6.0	34	NE	3.86	2.39	14
Bismarck, Dak.	69.5	96.	49.	47.	8.8	47	NW	3.96	0.67	14
Average.	69.5	90.9	52.4	38.5	6.6	40.1		3.19	1.21	11.6
Southern Cities										
Washington City.	73.0	94.	56.	38.	5.	18	S.SW.W & NW	4.47	2.98	10
Louisville, Ky.	77.8	95.6	60.8	34.8	5.1	24	W & SW	3.59	1.98	11
St. Louis, Mo.	79.0	97.9	64.5	33.4	7.7	36	N & NE	2.09	1.49	9
Savannah, Ga.	78.5	99.1	66.9	32.2	6.4	28	NW	0.81	0.31	6
Leavenworth, Kan.	79.0	97.	60.5	36.5	5.3	38	SE	4.87	1.33	6
Jacksonville, Fla.	80.2	98.4	68.	30.4	4.6	22	SW	8.30	3.47	13
Chattanooga, Tenn.	78.0	95.7	65.5	30.2	4.4	25	W	2.07	1.49	6
New Orleans, La.	81.5	96.5	72.	24.5	6.	36	S	2.02	0.34	15
Memphis, Tenn.	81.	97.	66.	31.	4.	19	W	2.12	0.84	10
Palestine, Tex.	79.8	94.5	63.9	30.6	6.5	26	NE	4.39	3.16	8
Average.	78.8	96.6	64.4	32.2	5.5	27		3.47	1.74	9.4
Western Citie										
Helena, Mont.	67.0	99.	46.	53.	7.1	36	SW	0.89	0.22	11
Port Angeles, W. T.				Not	received					
San Francisco, Cal.	59.1	93.4	51.	42.4	11.6	38	W	0.01	0.01	1
Salt Lake City, U.	76.5	97.9	51.7	46.2	5.5	32	S	0.34	0.11	7
Denver, Col.	71.4	100.3	51.4	48.9	6.5	36	S & SW	0.41	0.14	13
Yuma, Ariz.	90.4	113.7	63.	50.7	7.2	25	S	0.04	0.04	1
Santa Fé, N. M.	68.8	90.	51.	39.	6.5	45	W	1.98	0.51	17
Average.	72.2	99.0	52.3	46.7	7.4	34.8		0.6	0.17	8.3

Some Remarkable Breaks in a Reservoir.

In a paper read May 7, 1888, before the Engineers' Club of Philadelphia, LEWIS W. LUKENS gave an account of three remarkable breaks which have occurred in the reservoir on Conshohocken hill. This reservoir was built in 1873; it is 151 ft. square at the top of the embankment, is divided into two compartments, and is about 200 ft. above the Schuylkill, from which it is supplied with water. Its capacity is about 1,000,000 galls.

The reservoir was constructed by raising the banks about as much above the natural surface of the ground as the excavation was below it, the excavated earth being used for the embankment. The earth is light, containing enough talc to make it feel greasy. The bottom and sides were lined with 18 ins. of stiff fire-clay put on in 3-in. layers and well rammed. The last course was a brick pavement washed over with hydraulic cement. Cast-iron inlet and outlet pipes were used, surrounded by masonry composed of undressed stone laid in hydraulic cement and extending to about the middle of the embankment.

Soon after the water was let in, the first break occurred, commencing just above the outlet pipe, following the line of the pipe through the embankment and laying bare the masonry surrounding the pipe. It broke through the embankment at about the natural level of the ground and was 15 ft. wide at the top and narrower at the bottom. The curious part of it, however, was that the ground below showed no evidence of a large body of water having passed over it, only a comparatively small part of the water having escaped that way.

The larger part of the water must have been carried off by a subterranean channel. This break was repaired by filling in with stiff fire clay.

The second break occurred in 1876 and was an absolute giving way of the bottom, with no apparent break in the bank. It was simply a hole 20 ft. in diameter, into which a line was let down 85 ft. without finding bottom. The ledges of rock seem to have inclined toward each other like the sides of a V, and the slippery earth was washed from between them. It seems possible that the water from the first break may have started this one. It was repaired by filling the crevices between the rocks, and then arching them over with masonry, going as far down as necessary to get a good foundation, in one case 34 ft. The hole was afterward filled with stiff clay and iron ore screenings, and the tops covered with hemlock plank upon which the regular lining of clay and brick was laid.

The third break occurred in 1879, taking away part of the partition wall and part of the bottom. A well near this break 80 ft. deep, and usually having 8 or 10 ft. of water in it, was emptied at the time of the break and has never held water since. Probably the water found its way to the river. This hole was filled with masonry and clay as the other had been.

The clay lining was then taken off the whole reservoir, and bottom, sides and partition were covered with heavy hemlock plank. On this plank 14 ins. of clay was laid and then the whole surface bricked as before. This time it lasted for eight years, or until the fall of 1886. At that time a small break was occasioned by the earth between two rocks being washed away at the side of the end embankment, near its bottom. The side planks were sprung by the weight of the superincumbent water, and through this opening the water had escaped by a subterranean channel. When relieved of the weight, the planks sprang back, which fact is attested by a number of small fish having been caught and crushed in the crack. This break was repaired in the usual way, and since that time there has been no trouble.

La Nature says that among the exhibits at the Paris Exposition of 1889, will be a terrestrial globe about 43 ft. in diameter, or on a scale of one-millionth.

ENGINEERING NEWS

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D. McN. STAUFFER. A. M. WELLINGTON.

EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

American Association for the Advancement of Science. The thirty-seventh meeting will be held at Cleveland, O, from August 5 to August 21, 1888. The headquarters are at the Hollenden.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, Aug. 21. Secy., S. M. Wickersham, Penn Building.

Engineers' Club of Kansas City, Mo.—Regular meeting, Sept. 3. Secy., Kenneth Allen, 19 Deardorff Building.

Civil Engineers' of St. Paul, Minn. — Regular meeting, Sept. 3. Secy. Geo. L. Wilson, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, Sept. 5. Secy., John Bogart, 127 E. 23d St.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reid, Waycross, Ga.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, Sept. 19. "House Drainage". Secy., S. E. Tinkham, City Hall.

Association of North American Railroad Superintendents.—Next meeting at the Southern hotel, St. Louis, Mo., beginning Sept. 19. Secy., Waterman Stone, Providence, R. I.

American Institute of Mining Engineers.—Next meeting at Buffalo, N. Y.; beginning Oct. 2. Secy., R. W. Raymond, New York.

Engineers' Club, Philadelphia, Pa.—Regular meeting Oct. 6. Secy., Howard Murphy, 1122 Girard St.

American Society of Mechanical Engineers.—Convention and annual meeting at Scranton, Pa.; beginning Oct. 15 Secy., F. R. Hutton, 280 Broadway, New York.

THE complaints presented to the Interstate Commerce Commission furnish ample evidence that the perplexing question of railroad rates is about as largely one of the rivalry of different cities and sections for commercial supremacy as it is a controversy between the railway owners and the public which depends on the railways for transportation.

A hearing was recently held at Chicago of the complaint of the Detroit Board of Trade, in which it was claimed that the city was discriminated against by the railways for the benefit of Toledo and Chicago. A delegation was present from the Toledo Board of Trade to see that that city's claims to recognition were not ignored. Evidently it will be impossible to please all the ambitious cities of the country, each of which is desirous of special advantages over its rivals. Another case of the same sort occurs farther West; Denver is anxious to secure through rates from the Eastern seabord on the same basis as the present rates to Missouri river points; but if it succeeds in this a howl will go up from Omaha and Kansas City, especially the latter town, that their commerce is being ruined by the wicked machinations of railroad monopolists.

A great deal has been said since the Interstate Commerce law went into effect, of the wickedness of the Canadian Pacific in competing with American lines on through traffic east and west. The matter has been taken up in the United States Senate and a committee of investigation is to look up the matter. This is very pleasing to Chicago and to the railways centering there; but St. Paul and Minneapolis do not relish the prospect of having a fence built across their new independent outlet *via* the Sault Ste. Marie at all, and have adopted resolutions calling on their representatives in Congress to see that their interests are not encroached upon.

IN testing the actual value of any new invention, the cardinal question to be asked is: "How will the benefit to be derived by the use of this device compare with the trouble and expense of establishing and maintaining it?" It is the misfortune of the typical inventor that while he may be able to estimate with some degree of fairness the cost of his device, he is always prone to over-estimate the benefit to be derived from its use. The Patent Office records are full of the results of such men's work; the only result which they ever attained. There are thousands of things which it is quite possible to do, and which would result in *some* benefit; but they are not done, simply because this benefit is too high priced. A typical example of this sort of invention is one of which a description is before us called a "Tootometer", the work of a Bridgeport, Conn., inventor. The device is to be placed in the cab of a locomotive and consists of a clockwork apparatus which moves a strip of tin-foil on which are stamped cross lines representing grade crossings. Whenever the whistle is blown, an indentation is made in the tin-foil, and a graphical record is thus given of the whistle alarms over the whole length of the run. These strips of tin-foil are carefully indexed and preserved for future reference and when in use they are locked to prevent any tampering with the record. This is all entirely feasible, and the probable cost of maintaining the system, looking after the "Tootometer" at the beginning and end of every run, etc. can be calculated quite closely.

Now for the benefit to be derived. We quote the printed account:

> "There are a large number of grade crossings in this State, upon which annually many lives are lost. The relatives of those killed invariably claim that the locomotive whistles were not sounded in time to warn the victims. The railroad companies, to protect themselves against damages, dispute the point so often taken.
>
> "In the event of a person being killed on a grade crossing, the tootometer will truthfully indicate the whistle blasts and denote the distance at which they were blown before the crossing was reached. The tin-foil strips can be produced at an inquest or in a court of justice in evidence, and dissipate the necessity of an immense amount of swearing as to the fact of the whistle having sounded or not."

Thus the benefit to be derived is not the saving of any fatality incident to the use of grade crossings; but in case an accident does occur, and in case a dispute does arise over the sounding of the whistle, the tootometer, if it was working perfectly at the time, will settle the dispute. Of course the account closes with the stereotyped statement that, "the inventor has assurances that his invention will go into very general use."

The last issue of the London *Railway News* continues a series of articles on the Railway Clearing House, by a chapter devoted to Lost Luggage. The article charges the loss of baggage in England directly and almost exclusively to "the neglect or carelessness of the traveling public in matters which should certainly be within their own control." That is, that travelers should look out for the safety of their own parcels, large and small, and not bother the agents of the railway company with matters that do not concern the company. This is the ruling principle throughout the article and in English practice, and the writer quoted can not see how even the "much vaunted express system of the United States" will help matters in England. We have heard much of the general safety of luggage in transit there, and the rarity of its straying; and considering the complexity of their railway systems and the stupidity of a certain large proportion of the traveling public, this occurrence is perhaps not so frequent as might be expected. But that it does happen, and happen oftener than is supposed, is evident from the detailed list for Aug. 1887, given in this article, of property lost, for a time at least, while in the care of the railway companies. This list for one month includes 13,848 trunks or "boxes," 5,304 portmanteaux, 1,133 hat-boxes, 3,677 leather bags, 2,914 baskets, etc. Umbrellas, canes, small parcels, etc., swell the total to 67,113 items, but these should not be counted against the system.

The radical difference between the English method and our system of "checking" is that our railway companies early recognized this very "carelessness and obtuseness" in the traveling public, and wisely concluded that it was best to assume the responsibility themselves for the safe delivery of baggage at some destination conforming with the traveler's ticket. The company is thus not only saved much annoyance, but the passenger is also greatly benefited in the avoidance of any personal supervision over luggage in even complicated transit, after he has once properly put it into the transporting company's care. The straying of baggage does occur with us at times; but it is comparatively rare under the system in general use. One feature that the article in our London contemporary does not touch upon in this connection is the fact that at railway termini in that country each passenger claims his own baggage, and gets it, without any check upon real ownership as far as the railway company is concerned. The writer of this has had his own trunk hauled out of a luggage-van by a London cabman, and was on his way out of the station within 3 minutes after the stopping of the train. It was very convenient; no delay; but, for all the railway officials knew or seemed to care, the trunk of some unlucky fellow traveler might just as easily have been secured. Under this loose system much baggage must annually go astray or be totally lost to its owner, as the seizure may be charged to stupidity or dishonesty. English thieves are hardly "obtuse" enough to lose a good opportunity of this kind. The fact is, that while we can undoubtedly learn some things from English railway methods, England would impose less work upon its lost luggage department by adopting in some form the American system of baggage-checking. On the Continent there is a lame attempt at some such system, in many sections, but it too is susceptible of vast improvement in a similar manner.

The fact that English engineers and English capital are to be interested in the completion of an abandoned tunnel under an American

river does not at first sound complimentary to our professional skill or to the enterprise of home capitalists. But in the case of the Hudson River Tunnel there have been so many internal complications of control in the past that both American engineers and investors have been a little wary of entering into the scheme. But as English capital is quite as cautious, these troubles must have been adjusted before either the prominent engineers, or the Bank of Scotland, who now back it, would have suffered their names to be used. There are some very interesting engineering problems to be solved in the execution of this work; but we think these can be safely left to Mr. BENJAMIN BAKER and Sir JNO. FOWLER. But if the engineers do fail in their tunnel work or are too slow, we will look for the American bridge of 2,800 ft. span that must sooner or later cross the Hudson river somewhere near this point.

The Keeley Motor Company, of Philadelphia, again last week called upon the courts of that city to force Mr. KEELEY to "forthwith disclose the secret of his inventions or discovery, and to take immediate steps to obtain patents for his alleged inventions." This is evidently a large-sized contract for Mr. KEELEY, and though he has taken 18 months to prepare himself since the last similar legal proceeding, it seems he is not quite ready to "disclose." The Theosophical Society, too, now accuses him of meddling with *Akasa*, astral fluid, or some equally intangible something that he ought to let alone. But the Theosophs dash the hopes of stockholders by also declaring that "the higher powers" will intervene to prevent the present generation, at least, from getting possession of this tremendous force, as man is not yet good enough to be trusted with it. Altogether the promise is not good for dividends and the "moting" of the motor.

The Computation of Earthwork.

It is a very common weakness among engineers to mistake precision for accuracy on good work and to expend upon certain problems which are really simple in their nature an immense amount of mathematical labor to obtain formulæ which shall not only be correct enough for all practical requirements under the conditions of practice, but which shall be equally correct under the exaggerated hypothetical conditions which can only be represented by diagrams. The most pronounced example of this tendency, perhaps, is in formulæ for frogs and switches; another is in methods for the computation of bridge strains; another is in formulæ for railway, field work, and still another is in formulæ for computing earthwork.

We know from experience that despite all that has been written on the subject we could fill a page or two of every issue of this paper the year round with discussions of frog and switch formulæ, by simply printing all that was sent in, and giving occasionally a little editorial push to the discussion. The comparative length of lead on turnouts from curves and tangents alone affords endless opportunity for mathematical gymnastics of so simple a nature that almost anyone can take part in them, and yet leading to equations of so complex a form as to give a very learned air to the discussion. Several books whose bulk is mainly due to elaboration of this subject alone have been published, and several more exist in manuscript, to our knowledge, and have only failed to see the light of print because of the brutal indifference of publishers.

Such waste of labor becomes comic after one has fully grasped the truth that in a practical sense the length of lead is precisely the same whether the turnout be from a tangent or from the inside or the outside of a curve; yet that it is so may be shown in many ways, and especially by a simple illustration which we may pause long enough to give.

Assume a model of railway track to be made of elastic wood, with the ties rigidly attached to the rails. Now spring the track into a curve, not the exaggerated curves which are drawn to make diagrams on paper, but into such a curve as is used in practice, say to a radius of 100 times the gauge, which will give about a 12° curve. In this case the outer rail will be lengthened and the inner rail shortened by about $\frac{1}{200}$ of the lead each, or 6 ins. each for a lead of 100 ft. If we had a third rail laid on the center line it would neither be lengthened or shortened.

Now, conceive a turn-out curve to have been laid down on this model before springing it into a curve. The lead rail runs diagonally across from the inner to the outer rail. That part of it where it crosses the center line will not be changed in length at all. That part of it toward the inside rail will be shortened and that part of it toward the outer rail lengthened. A moment's reflection will show, consequently, that if the lead rail were only a straight diagonal from one rail to the other its total length would remain absolutely unaltered by springing the main rails into however sharp a curve in either direction; but as the lead rail is not straight but on a curve the lead-rail will be somewhat shortened if the turn-out be to the outside of the curve and somewhat lengthened if it be to the inside by a total amount which is readily shown to be about *one-sixth of the total difference in length between inside and outside rails for the length of the lead*, or about 2 ins. for a 12° curve and 100 ft. lead. No sensible person attempts to work within 2 ins. in the length of a lead, nor is it worth while to trouble ourselves much to do so within 2 ft., since the slightest amount of compounding in the turn-out curve will make that amount of difference in the lead.

In the computation of earthwork there are many equally absurd examples of wasted labor, which are the more objectionable because there are so many more computations of earthwork volumes than of frogs and switches.

The only great desideratum in computing earthwork is to avoid any tendency to cumulative error while simplifying the process as much as possible. It is to be remembered in regard to earthwork that many causes combine to forbid any great accuracy in the result, however elaborate the process of computation, and even to make great accuracy in it unimportant. Thus, let us take a prism 30 ft. deep, 20 ft. roadbed, 1½ to 1 slopes, hence 110 ft. wide on top, and 100 ft. long. A difference of 0.1 ft. in the height of any single stake makes a difference of nearly 7 cu. yds. in the volume, and a difference of 0.1 in the height of all the stakes makes a difference of over 40 cu. yds. A bellying of the slopes of only 2 ins. at the center makes a difference of over 20 cu. yds.; a starting of the slope only 0.2 inside the slope stakes, even without any subsequent bellying of the slopes, makes a difference of over 40 cu. yds. in the volume; a very slight crowning of the earth between the slope-stakes, such as would be almost certain to escape notice in cross-sectioning—say of 0.2 in 55 ft. on one side of the center line only—makes a difference of over 20 cu. yds.; and so we might go on with other causes of error.

Now all these causes mentioned are extremely common. Slopes are almost invariably bellied more or less, and a belly of even 6 ins. in the slope of a 30 ft. cut is by no means rare and would pass the inspection of most engineers, since the eye does not readily detect it. A perfectly straight slope produces the impression on the eye of a slight concavity. Similarly, few or no slopes start directly from the slope stake. Laying a straight edge on the top of almost any slope it will be found that there is a foot or two of very flat slope at the beginning, and that except for it the true slope would cut the original surface at a point several inches inside the stake.

These two sources of error are made in favor of the contractor, but on the other hand the top of almost all cuts is somewhat curved, and the bottom of almost all fills somewhat concave, requiring an excess of material for which the contractor only gets allowance when the convexity or concavity is extreme, and then only by taking a single intermediate which still leaves the same error in principle in the notes, somewhat reduced in magnitude.

For all these reasons the cut of over 6 or 8 ft. in depth whose true volume as excavated is given by the notes within 5 or 10 cu. yds. is a rare exception. It is a favorite delusion of inexperienced and over-precise men to believe the contrary, and hence to devote a vast amount of labor to carrying out decimals to the bitter end, and to look askance on any method of computation which may give a result a yard or two different from what a precise application of the prismoidal formula to the face of their notes might indicate; or still more object to anything but a decimally precise application of the confessedly inaccurate method of "averaging end areas" in their notes.

What is plainly needed, to deal properly with the problem, is an analysis of the conditions by which the maximum of practical accuracy may be obtained with the least labor without any tendency to cumulative error, rather than a rigid application of theory to particular solids, and rejection of all methods which will not be true, not only with the class of solids practically met with, but with any fantastically formed mass which an ingenious pencil can devise. We cannot afford to weigh hay in a chemist's balance, nor is it sensible to attempt to do so.

Viewing the problem in this way we soon find that a direct application of the prismoidal formula is not a rational nor defensible method of computing ordinary earthwork, and fortunately it is much less frequently attempted in practice then laid down in text-books. The prismoidal formula in which E = the end areas and M = the middle area is one of a truly wonderful range of application to a wide variety of solids, bounded by both curves and straight lines, but its direct application requires the laborious determination of the middle area from the means of corresponding dimensions of the end areas. The "end area" method $\left(\frac{E+E'}{2}\times l\right)$ is extremely convenient and simple, and is much more largely used than any other, but it has the disadvantage of giving a large excess of volume on certain solids, and a certain excess in nearly all solids. It is a common idea that it gives an excess of volume in all cases, but this is not the case, except in comparison with an inaccurate method of applying the prismoidal formula, known as the method of "equivalent level section" of which we shall speak in a moment. Whenever the two center heights of a solid are the same, whatever the width on top, or whenever the two widths on top are the same, whatever the difference of center heights, the "end-area" solidity is correct, or the same as the prismoidal formula gives, although the "level

$$\frac{E+E'+4M}{6}\times l$$

soction" method alluded to gives a smaller volume in each case; and whenever the smallest center-height is at the same end of the solid as the greatest width on top, the "end area" volume will actually be too small, although the "level section" method of applying the prismoidal formula gives a still smaller volume.

But these last are very exceptional cases which will not occur once in a thousand times. The practical question is: What is the nature and extent of the error in the application of the "end-area" method to the the ordinary solids of practice, and is it possible to avoid all evil effect from this error without abandoning the simple method of computation? Viewed in this way we find that for cuttings of any kind having a fixed bottom width, side slopes of any uniform rate s, and a surface level, the difference between the "end-area" and the true prismoidal volume is expressed by the formula

$$D = (c-c')^2 s \frac{l}{6}$$

in which D = the difference in volume required, c and c' = the center heights, and l = the length of the solid. If the surface, instead of being level, be assumed to have a different surface slope on each side of each section this formula assumes the similar but more elaborate form

$$D = (c-c')(w-w')\frac{l}{6}$$

in which c = the center height and w = the width on top from out to out.

Now it is apparent from these equations that the error in using the simple "end-area" method is quite independent of the absolute magnitude of the solid of the absolute center heights, and of the width of roadbed, but varies only with the *difference* in the center-heights, since the widths on top, in any average solid, may be said to be merely functions of the center heights. The amount of the error, moreover, varies as the *square* of the difference in center heights, so that, while a moderate difference gives a very small value to the equation of difference, the percentage of error increases very rapidly as the differences of center height become great. Thus for a difference in center height of 1 ft. we have for D, assuming the solid to be 100 ft. long, 25 cu. ft. or 0.926 cu. yd., an entirely unimportant error; but if the difference of center height be 10 ft. we have 100 times as great an error, or 93 cu. yds.

Hence we see that, to be safe in using the simple "end-area" method we have only to avoid differences of more than about 2 ft. in center heights, and for all solids in which we do this the averaging of the end areas gives quite near enough to the true volume. This good cross-sectioning ordinarily requires, but the ease with which we have determined the extent of the error in so doing on given solids suggested further that we may use the simpler method for the original determination of all the quantities, and then obtain the true quantities for a final estimate simply by determining a "prismoidal correction" afterwards for such solids as need it, *i. e.*, for those solids which the notes show to differ more than 2 ft. in center heights. Again, remembering that the two end sections of any one solid have ordinarily, approximately similar slopes, it will be seen that the difference in the widths on top $(w - w')$ is so nearly equal to $(c - c')\,s$ (almost invariably somewhat more) that the only effect of determining the prismoidal correction by the simpler formula first given, instead of by the more elaborate one given afterwards, is to give a prismoidal correction slightly too small, *i. e.*, a final volume slightly too large, which is but fair to the contractor. In fact, actual tests of a large number of actual solids, regular and irregular, show that the final result of computing earthwork on this assumption is to give a volume very slightly in excess of that given by a vigorous application of the prismoidal formula to all the solids regular and irregular, and hence one which is probably nearer to the true volume of the earthwork, properly executed, than the rigorously exact method.

On the other hand, the method of reducing all sections to an "equivalent level section" of equal area, before computing the volume, while it has a certain convenience for constructing tables of earthwork volumes, involves a good deal of labor to worse than no purpose, for the volume thus obtained is *always* too small under all possible conditions. The error thus resulting on each particular solid is a small one, but it is a cumulative error and one in the wrong direction. This is readily shown mathematically or by trial on any solid. If the method were much simpler than any other, the error might perhaps be endured with proper precautions; but nevertheless as the method is not only less accurate but more laborious than others, when a large number of solids are taken together, it ought to be excluded from the practice of engineers.

The true rule for the computation of every form of earthwork is that outlined above; to compute the volumes primarily by the simple method of averaging end areas and then, at any later convenient season during the progress of the work, to determine prismoidal corrections for such solids as need them, to be deducted in gross from the "end area" volume assuming each section, for this purpose only, to be a level section of its actual center height. In this way we obtain what is demonstrably the closest possible approximation to the actual volume of a large number of solids, while the additional labor of applying the prismoidal formula in this way, aided by a very brief table, is too trifling for consideration.*

*A fuller demonstration of some of the facts here stated may be found in "Computation of Earthwork from Diagrams," by A. M. Wellington, C. E. New York, D. Appleton & Co. and ENGINEERING NEWS.

M. de Lesseps Report of Aug. 2 to the Panama Canal Company.

The last number of the *Bulletin du Canal Interocéanique* received contains the full text of the report of M. DE LESSEPS to the Panama Canal Company at its 10th meeting of Aug. 2, 1888. This text as compared with the portions sent out by the company and published in the French newspapers, and even in the London *Times*, furnishes some curious reading in the parts omitted in the press accounts. Space forbids the publication of this document in full, but a few extracts from the parts not generally made public will, we think, show that these have even more important bearing upon the immediate future of the Canal enterprise than the other portions so judiciously selected.

Confining ourselves to the "expurgations" solely, and using italics where needed, the following practical admissions are made in this "frank statement" of M. DE LESSEPS, parts of which are too frank for popular use: He first says that "the time has come to stigmatize the *miserables* whom I denounced in my letter of June 29, and to tell you with brutal frankness both *the dangers you have run* and the efforts we have made to defend your work." He next refers to "our *anguish*, when, week after week and day after day, *our means were drained* while awaiting the vote and the promulgation of the law which we had asked for." Both of these admissions picture the financial straits of the company and the almost hopeless state of suspense of its administration. And the evil day was only turned aside when "certain credit concerns, steady in the help which they had never refused, witnesses of our uprightness, *lent us 30 million francs* at the very moment, the eve of the passage of the Senate bill, when our adversaries were already announcing with a cry of victory the failure of the Maritime Canal of Panama."

Strange to say, all mention of this 30,000,000 borrowed on the eve of the vote is carelessly omitted in the press accounts, though it does figure under "various creditors, 35,200,000 frs." in the estimate of expenses and receipts for the year ending July 1, 1890. But this estimate is likewise suppressed.

M. DE LESSEPS admits the failure of the last popular subscription in his statement that after its success had seemed assured—"It was then that your adversaries, by odious means already exposed in our complaint to the Public Prosecutor, *hindered this success.*" The crisis that this failure brought about in the Canal Company's affairs was only averted by "the help of a financial group, composed of great credit concerns and bankers who have always been faithful to the works of Suez and Panama," who interposed "to consolidate the success of an issue so violently opposed and secure the progress of the enterprise on the best conditions." This syndicate while it evidently saved the company at a critical issue, had not been implicitly relied upon by M. DE LESSEPS, for later in his speech he betrays the fact that he had in contemplation an entire suspension of the interest account "as the shareholders of Suez did after the wicked war of 1879; in the moment of danger, you, too, would have renounced your rights temporarily to save your property, listening only, as M. DE FREYCINET said, to your courage and your honor."

In speaking of the issue of the lottery bonds, of June 26, last, M. DE LESSEPS rather boasts that—"Securities of the new issue, 3d series, have been taken in payment for lottery bonds at the price of 460 francs, and 20,371 bonds have up to this time been exchanged for lottery bonds." While the speaker refers to this operation as lightening the company's charges, he seems to forget that it also reduces the amount of *cash* received by the company, from the lottery bonds, by an amount of 9,370,660 francs, or nearly $2,000,000 deducted from the available capital in hand.

The lengthy statement of the company's account is omitted, for the same reason that *perhaps* actuated the French press; that is, that it is more than a year old, and is therefore of very little value in studying the present condition of the company's finances. The expenses for the year ending June 30, 1887, the date of the statement, are placed at 204,366,145 francs; but since that date three loans have been issued, and the charge for interest and sinking fund must have been nearly doubled. The cash balance on Jan. 1, 1888, according to this account, was 110,000,000 francs, or $22,000,000.

The report gives in "conclusive figures", "our estimate of the expenses and receipts from July 1, 1888, to July 1, 1890", as follows:

	Francs.
Work remaining to be done to complete the canal	333,600,000
Administration on the Isthmus	24,000,000
Interest and sinking fund	203,000,000
Administration at Paris	4,000,000
Unpaid coupons	6,400,000
Due bills	1,000,000
Various creditors	35,200,000
Total	607,200,000

This is a frank admission that the fixed charges and administration at Panama and Paris amount to $22,500,000 per year, and that the company owes $8,520,000. The estimate for the "completion" of the canal is, of course, absurdedly minimized.

M. de LESSEPS then figures out that with the product of the lottery loan of June 26 last, "and our available balance" the canal can be opened on July 1, 1890, and all expenses of work and fixed charges met in the meanwhile. But as this prophesy is based upon the *full subscriptions to the lottery loan*, and as the "132,670,3.5 francs *capitaux disponible*" is only to June 30, 1887, a statement founded on figures one year later, or June 30, 1888, would show a very material difference. One of the humbugs of the Panama administration is this presentation at annual meetings of financial statements one year old.

The "condition of the works" as given in the same report is instructive. It shows an unsatisfactory and bad condition of affairs in the 2nd, 3rd and 4th sections of the line; threats of rupture with the contractors on these sections, and the default of the contractor on the minimum cube of extraction fixed in the contract for the 5th section. As these sections include those parts of the canal lying between Bohio Soldado and Paraiso, they include every foot of the difficult portions of the work.

Messrs. ARTIGUE & SONDEREGGER, who are praised for their "zeal, devotion and intelligence", at Culebra, are the same contractors who have failed to reach their contract minimum, and are the same parties who have been looking for six months at the hard gray rock at Bohio Soldado without an attack. (See the letter of Mr. SNOW in our issue of June 16.) The same formation runs through the contracts of VIGNAUD, BARBAUD, BLANLEUIL & Co, from Bohio to Matachin, and this includes nearly one-quarter of the company's admitted total cube of excavation. The *Société des Travaux Publics* have about one-seventh of the total cube in their section, including the rock region from Gorgona to Culebra. But while this company is one of the old friends of the enterprise, relations seem to be becoming strained and M. de LESSEPS threatens them with "the most rigorous measures."

The fact of the matter is that the contractors, who in this report are being lectured and threatened for the unsatisfactory character of their work, have 19,359,000 cu. m. out of the total 34,449,000 cu. m., which the Company's estimate concedes. The admission is thus fairly made that more than one-half of the work yet to be done is enormously more difficult than any other part of the work.

M. de LESSEPS "reports progress" only on the Eiffel locks; but states that "nothing up to the present time justifies a doubt of the complete and strict fulfillment of the contract." There are 15,000 cu. m. of broken stone on hand for the masonry, anyhow, and 19,000 tons of castings and 15,000 tons of wrought iron "have been ordered." He singularly omits to say anything about the water supply for the locks or the plans for the Gamboa dam; though a lock-canal with the upper levels dry would hardly be considered a commercial success.

One feature of this reports accords well with the remarkable methods of the Panama Canal administration; and that is, that M. de LESSEPS should, on Aug. 2, at the end of the seventh month of the year of grace, announce that contracts beginning on Jan. 1, were not being executed, and that if "by the end of the year" some improvement was not noted the company's agents would see to it. The Canal Company cannot afford to quarrel with these contractors at this stage of the game; and if they do quarrel it will most probably be with a fixed purpose and the mutual understanding that the end of the rope has been reached.

"Recent Nicaragua Ship Canal Surveys."

This is the title of a paper read by Civil Engineer R. E. PEARY, U. S. N., Sub Chief Engineer of the Nicaragua Canal Construction Company, this week, at Cleveland, O., as part of the proceedings of the American Association for the Advancement of Science, at its annual meeting.

Mr. PEARY said that these surveys, executed upon the general plans formulated by Civil Engineer A. G. MENOCAL, U. S. N., who can justly claim to be called the evolutionist of the Nicaragua route, have given more than satisfactory results, and plans and profiles are prepared for submission to the Association, based upon information as complete and accurate as any upon which a work of similar magnitude was ever commenced. The results are due to the master mind that planned the work, and to the fearless, hard working engineers who, in spite of obstacles and hardships, cut their way through the tropical tangle until they knew the shape of every hill and the course of every stream. The methods of work were as follows:

The expedition being divided into parties and the work into sections, the locations of 1880 in the Western Division, and of 1872-3 and 1885 in the Eastern, were taken as bases, and a main transit and level line run, and benchmarks established about every 1,000 or 2,000 ft. These benches were then checked. From this transit line, compass, chain and aneroid offsets wese run from 1,000 to 2,000 ft. on both sides, adjacent streams, valleys and hills reconnoitred, and the work plotted; with this chart in hand the entire line was then gone over in the field by the Engineer in Charge, accompanied by the Chief of Section, and the location decided upon. The location was then run in and leveled, checking upon the benches of the preliminary line, and cross-sections run and leveled from 100 to 400 ft. apart, along the main line, as the topography demanded. Sometimes portions of this location were modified and re-run. Streams were then surveyed and gauged, neighboring elevations beyond the limits of the canal taken with the aneroid, and the entire work plotted on a 400 ft. scale with 10 ft. contours.

The boring party then went over the line, boring on all summits and in all depressions and penetrating to the level of the canal bottom unless rock was encountered sooner. Borings were also made on the sites of all locks, dams and embankments.

The work accomplished by the Expedition is as follows:

In the Western Division, two locations, one for a canal in excavation the entire distance from the lake to the Pacific, and one for a canal with a basin at La Flor.

Survey of Brito Harbor and of the lake in the vicinity of the mouth of the Rio Lajas.

In the Eastern Division, survey of the lake from the mouth of the Rio San Juan to deep water.

Re-survey of the upper San Juan from Fort San Carlos to Castillo.

Two locations from Ochoa Dam to Greytown, one surveyed by the Government Expedition of 1872-3, and known as the Lower Route, and the other surveyed by the Government Expedition of 1885, and known as the Upper Route.

In all, the Expedition cut, ran with transit or compass, and leveled 500 miles of line, and ran 400 miles of soundings.

The first location in the Western Division is practically the same as that of 1885. The second location includes a basin 5.28 miles long, with a depth of 30 to 70 ft., formed by impounding the waters of the rivers Tola and Rio Grande. A double lock of 85 ft. lift at the northern end of the dam, and a second lock of 25 ft. lift one mile west of the double lock, drop the canal to the level of the Pacific. The total distance of 17 miles from the lake to the Pacific is not affected by this modification, but 5.28 miles of lake navigation are substituted for an equal length of canal, the actual canalization being reduced to 11.72 miles, one lock is dispensed with, and the problem of the disposition of the Rio Grande drainage is much simplified and that of the Tola eliminated entirely.

The Middle Division, comprising the lake and the river, remains as in the plan of 1885.

In the Upper Route of the Eastern Division, the long embankment proposed in 1885 across the main valley of the San Francisco below the junction of the Chanchos is replaced by five shorter dams about 1,700 ft., 1,300 ft., 1,400 ft., 1,700 ft., and 1,200 ft., respectively, across the valleys of the Chanchos, San Francisco and tributaries, and there will be some secondary embankment at various points along the crest of the impounding ridge, with a depth varying from 5 ft. to 30 ft. The sailing line is shifted farther north and the flooded area in the San Francisco basin reduced.

The rock cut through the San-Francisco-Deseado divide is practically the same as that of 1885. The lift of Lock No. 3, at the eastern end of this cut, is reduced from 53 to 35 ft. This change, in combination with a dam and a second lock, of 40 ft. lift, farther down the Deseado valley, gives a basin 3.84 miles long and with a depth of water of from 25 to 40 ft., requiring excavation to an average depth of 2 to 3 ft. along 1¼ miles of the upper half. Lock No. 1, ten miles from Greytown, has a lift of 31 ft.

These modifications largely reduce the excavation, increase the free navigation, and obviate the necessity for lateral drains between Locks Nos. 2 and 3.

The total distance from ocean to ocean is, as before, 169.8 miles, but of this only 28.9, instead of 40.3, is canal in excavation, the remainder being open navigation through lake, river and basins. The length of the summit-level is increased from 144 miles to 150.

The Lower Route is identical with the Upper as far as a point about 2¼ miles east of Ochoa Dam. At this point of divergence either a single or a double lock of 56 ft. lift lowers the canal to within a few feet of the San Francisco valley level, and then the canal extends across this valley, behind low hills lying nearer the San Juan, its level kept up by an embankment about 15 ft. high, supplementing the hills, towards the bend of the San Juan, where the San Francisco hills come to the river. From this point it extends in a straight line to the Serapiqui hills, 6½ miles lower down the river, being kept up through this section also by a low embankment on the river side. In these hills the second lock, of 20 ft. lift, is located. Thence the canal extends to the San Juanillo, still following the general course of the San Juan, and thence in a nearly direct line to Greytown, through the delta of the San Juan, the Silico hills, where the third and last lock is located, and the Silico lagoon. The additional length of this route over the upper is 6.6 miles, and, excepting the portion through Lake Silico (1.53 miles), it is all canal in excavation. Though based upon the location of 1872-3 it is 3½ miles shorter, has about half the number of curves, and has no curve of less than 6,000 ft. radius, and it can be located without a curve of less than 10,000 ft. Its disadvantages, compared with the Upper Route, are greater length and consequently greater cost of maintenance.

Thus we have at Nicaragua two perfectly practicable routes, of about equal cost, either of which is far superior to any other routes across the Isthmus, and when the day comes, as it surely will, when one canal cannot accommodate the traffic seeking it, then the other can be built and give one canal for eastward and one for westward bound vessels.

The computations of the notes of the surveys being yet incomplete precise quantities and estimates cannot now be given. In general, the quantities in the sections where no modifications or only slight ones are made will be the same as those of 1885, while the saving in the modified sections will be from $10,000,000 to $15,000,000. The item of earth excavation, with its varied plant of excavators, cars, locomotives, etc., and its attendant expense of maintaining and shifting tracks, and handling material in rainy weather, is reduced to a minimum, and the construction work will fall practically under the three heads of hydraulic mining, rock excavation and dredging,—all independent of drainage and rain. The work can be prosecuted day and night without interruption.

Numerous borings have made an end of the bottomless swamps, semi-liquid quicksand and numerous other subterranean bugbears which have been conjured up against this route, and have shown that in no portion of either line is there any trouble about foundations. In the worst swamps the boring implement, after sinking with its own weight perhaps 10 or at most 15 ft. reached a stratum of firm red clay extending to bed rock.

The experience of the Expedition is worth volumes as evidence concerning the effects of the climate of

Nicaragua. During the seven months it was in the field not a man out of nearly 200 was lost, and there was not a single case of serious illness.

The size and capacity of the canal will not vary materially from the plans of 1885. The number of locks will be reduced to six and possibly five, and the time of lockage to thirty minutes. The general dimensions and methods of construction of the locks are not changed, but the double lock at La Flor is a new feature.

The Nicaragua Canal, its General Features, and the Results Anticipated from its Construction.

The following is an abstract of a paper by Mr. J. C. HUESTON, read by Commander H. C. TAYLOR, U. S. N., on Friday, Aug. 17, before the annual meeting of the Association for the Advancement of Science, at Cleveland, Ohio:

Since the last annual meeting of the Association, the surveys in Nicaragua, and the preparations in this country and Europe, have developed much that is new in the engineering and other features of the canal enterprise.

The utilization of natural basins, and the creation of artificial ones in the valleys of the rivers San Francisco, Deseado and Tola, will afford such an extent of free navigation, in addition to that in the San Juan River and Lake Nicaragua, as to leave little more than one-sixth of the total length of the canal to be excavated in order that this "vast gate of the twin sea" may be thrown open to the ships and commerce of the world.

The climatic conditions on the canal route have been demonstrated to be favorable by the absolute immunity from disease of every kind enjoyed by the surveying party, numbering nearly 200 men, during six months of exposure, under trying circumstances.

It has also been shown that Nicaragua and neighboring countries can supply plenty of good material for the supply of manual labor needed on the work, rendering this part of the problem less difficult of solution than has heretofore been apprehended, and that these countries will also furnish the necessary provisions for the sustenance of the working force.

The survey just completed was not a preliminary nor an experimental one. It was an exhaustive scientific examination of a definite line, and the result is a more detailed and accurate map of the part of Nicaragua affected, than exists to-day of the State of New York.

The contract of 1887, with the Republic of Nicaragua, has been supplemented recently by one of similar tenor with Costa Rica, perfecting the exclusive title of the Canal Association. A bill to incorporate the "Maritime Canal Company of Nicaragua" has passed the United States Senate, and now awaits the action of the House of Representatives, having been favorably reported to that body, by its Committee on Commerce, with the expression of the Committee's full satisfaction as to the financial standing of the Association.

Statistics of the U. S. Treasury Department, and of foreign countries, agree that if the canal were open to-day, 4,500,000 tons of traffic would be within the zone of its attraction, and the development of our northwest Pacific coast territory will probably increase this to 6,000,000 by the time the canal is opened, say in 1894. Over half of this traffic belongs to ports of the United States. The canal will save 10,000 miles over the Cape Horn route, and give American merchants and ship-owners an advantage over those of western Europe, of several thousand miles, in the place of a disadvantage of like extent under which they now labor, in that competition.

THE Chamber of Commerce of Sheffield, Eng., recently passed resolutions favoring the construction of a canal 50 miles long between Sheffield and Goole, to cost about $5,000,000.

THE bill placing the telegraph companies of the United States under the jurisdiction of the Interstate Commerce Commission and forbidding personal or local discrimination by telegraph companies doing an interstate business, has passed the Senate without opposition. The bill provides that all rates shall be just and reasonable, a general phrase whose various interpretations are likely to leave a wide latitude for disagreement between the telegraph companies and the public who use their lines.

Progress Record on the New Croton Aqueduct to Aug. 4, 1888.

The general summary of tunnel work on the new Croton Aqueduct stood as follows on Aug. 4, according to the official report of that date to Chief Engineer BENJAMIN S. CHURCH:

Contractors.	Excavated Heading. Lin. Ft.	Unexcavated Heading. Lin. Ft.
Brown, Howard & Co.	66,019.9	0.0
O'Brien & Clark	54,403.5	33.0
Heman Clark	24,057.0	0.0
John Brunton	11,900.0	0.0
Total Aqueduct	156,380.4	33.0

Total Miles of Tunnel Excavated to date	29.7219
Miles of open cut " "	1.1226
Total miles of tunnel and cut	30.8445
Miles of unexcavated tunnel	.0063
Total miles of aqueduct	30.8508

The summary of masonry in the tunnels to the same date stands as follows:

Lineal Feet of Masonry Completed to Aug. 4, 1888.

Character of work.	Brown, Howard & Co.	O'Brien & Clark.	Heman Clark.	J. Brunton & Co.	Total Aqueduct.
Invert	60,458.1	31,542.0	24,057.0	10,592.0	126,649.1
East wall	65,308.1	50,257.0	1,890.0	0	117,455.1
West wall	65,598.1	49,872.0	1,890.0	0	117,360.1
Arch	65,149.1	49,362.0	24,006.0	9,756.0	148,273.1

Lineal Feet of Masonry Remaining to be done, Aug. 4, 1888.

Invert	5,591.8	22,819.5	0.0	1,308.0	29,719.3
East wall	741.8	3,103.5	51.0	2,144.0	6,040.3
West wall	451.8	3,488.5	51.0	2,144.0	6,135.3
Arch	900.8	4,999.5	51.0	2,144.0	8,095.3

PERSONAL.

SOL HAAS, Traffic Manager of the Richmond & Danville R. R., has resigned, to accept a similar position with the Chesapeake & Ohio R. R.

R. R. BRIDGES, of the Western North Carolina division of the Richmond & Danville R. R., has been appointed Engineer of the Virginia Midland R. R.

M. W. MATHER has been appointed General Superintendent of the Colorado Land & Improvement Co. and is in charge of work at Glenwood Springs, Col.

L. N. POLK, Chief Engineer of the Louisiana & Arkansas R. R., is engaged in making a survey of that road. He expects to reach Delhi, La., on September 1.

A. W. CLUBB, formerly of the Michigan Central, has been appointed Contracting Agent of the Toledo, St. Louis & Kansas City R. R.

T. O. TROY, formerly of the Richmond & Danville R.R. has been appointed superintendent of the Atlanta & Florida R. R.

BENJAMIN THOMAS, formerly General Superintendent of the Erie road, and at present holding a similar position with the Chicago & Atlantic, has been elected General Manager of the Chicago & Western Indiana road, and General Manager of the Belt Railway, of Chicago. He succeeds in those positions JAMES D. CARSON, resigned.

CHARLES CROCKER, Second Vice President of the Southern Pacific Railroad, died at Monterey, Cal., Aug. 14. He was born Sept. 11 1822, and like many of our railroad magnates, began life at the bottom of the ladder, his first employment being logging in Indiana, but he worked himself up and became a prominent man at Sacramento, Cal. The most important work of his life was in connection with the Central Pacific Railroad.

In the fall of 1860 he was elected by the Republican party to the State Legislature, and while the Legislature was in session the Central Pacific Railroad was first proposed. He joined with MARK HOPKINS, LELAND STANFORD, and COLLIS P. HUNTINTON in an agreement to furnish the money necessary to make a practical survey of a route across the Sierra Nevada. THEODORE D. JUDAH, an eminent engineer, ran a preliminary line from Sacramento to the Truckee river, on the east side of the mountains. JUDAH was then sent to Congress. The result was a bill organizing the Union Pacific and authorizing the construction of the Central Pacific from San Francisco east to Ogden. Crocker took the contract to build the first 18 miles of the Central Pacific, and afterward built 2 miles of the next 13. He also took up the work of those contractors who had not been able to complete what they had agreed to. He followed this by building the road from New Castle to the State line on the eastern side of the mountains. When the Contract & Finance Co. was organized he bought a large proportion of its stock and became the President. Under his superintendence the railroad was completed to Ogden, Utah. As the President of the Contract & Finance Co. he also built local lines in California, and supervised the construction of nearly all the California roads tributary to the Central Pacific. The first 100 miles of this railroad cost $20,000,000, of which $4,000,000, was provided by the Government and the other $16,000,000 was raised by HOPKINS, HUNTINGTON, SANFORD, and CROCKER. In 1871, CROCKER was elected President of the Southern Pacific Railroad Co. In 1884 the road increased its capital from $1,000,000 to $100,000,000, and was reorganized with a vast system of branches, including the Central Pacific. The reorganized road is known as the Soutnern Pacific Company. In 1873, after an eighteen months' trip to Europe he was elected Second Vice-President of the Central Pacific Railroad Co., and President of the Southern Pacific Company. Later he became Second Vice-President of the Southern Pacific Railroad Co.

Petroleum as Fuel.

In a lecture delivered before the Franklin Institute in January, 1888, Dr. CHARLES B. DUDLEY, chemist for the Pennsylvania Railroad Co., spoke first of the various efforts made to obtain a successful apparatus for burning oil. Until very recently experimenters tried to turn the oil into gas before burning it. This method was not successful, as the process was expensive and the gas was apt to clog up in the generator. It is impossible to say who first struck upon the essential feature of successfully burning petroleum, which is to use it without previous preparation, but Mr. THOMAS URQUHART, Locomotive Superintendent of the Grazi-Tsaritsin Railway of Russia, made the first successful attempt to use it on a large scale. In October, 1886, Mr. URQUHART had 143 locomotives using nothing but petroleum as fuel, as well as all the stationary boilers on the whole line.

In the apparatus for burning the oil, it is finely divided by a steam jet issuing from a small tube within a larger tube, from which the supply of oil is drawn. A mass of fire-bricks in the fire-box serves as a combustion chamber and, to a certain extent, for the storage of heat. The burner does not project into the fire-box, but the orifice is about 1 in. from it on the outside. This arrangement obviates the heating of the burner, and the consequent deposit of carbon and clogging up.

It will be observed that, as steam is required for burning the oil, it will have to be provided from some outside source when the locomotive is cold. On the Grazi-Tsaritsin Railway connection is made with a locomotive having steam up, or if in the round house, with appliances for the purpose, the steam being furnished by a stationary boiler. Compressed air may, of course, be used for getting up steam and for continuous running, and it has been frequently tried, but shows no advantages over steam.

The firing of a petroleum burning locomotive can be done to perfection. The fireman stands at the wheel controlling the supply of oil, and watches the steam gauge and the smoke-stack. If he catches a glimpse of black smoke, he at once diminishes the supply of fuel. When steam is shut off, the oil is shut off, and the steam gauge remains almost stationary. The character of the fuel and the perfection of the details of the appliances for burning it, permit the most perfect adjustment of the supply of fuel to the requirements of the grade and the strength of exhaust and consequent supply of air, so that no smoke or cinders escape from the stack to the discomfort of passengers.

It is safe to say that this part of the problem is solved, and that oil burning, so far as it depends upon methods of burning, can be successfully ac

complished. The problem remaining is whether it is an economical fuel.

Experiments have been made by Mr. URQUHART, by the Peninsular Car Co., and on the elevated railroads of New York to find the relative heat producing values of oil and coal. The results of these experiments agree very closely, and prove that 1 lb. of oil is equivalent to about 1¾ lb. of coal.

Assuming that a barrel of oil contains 42 galls. weighing 7.3 lbs. per gall., it is easily found that the relative values of oil per barrel, and coal per ton of 2,000 lbs., fuel account alone considered, are as 1 to 3.73. Or a barrel of oil at 20 cts. is equivalent to a ton of coal at 74 cts.; oil at 50 cts. per barrel is as expensive as coal at $1.86 per ton; and a barrel of oil at $2.00 is as good as a ton of coal at $7.45.

When all the ascertained economies are considered the relative values are somewhat changed, the ratio between the cost of a barrel of oil and a ton of coal (2,000 lbs.) being as 1 to 3.26 to make them equally economical. Therefore, oil at $1 per bbl. is the same as coal at $3.26 per ton.

It is not difficult to see why oil has not been generally used in this country for heat producing. It is simply because it is more expensive than coal.

Dr. DUDLEY continues on this subject as follows:

"On the Pennsylvania Railroad, it was actually found, with oil at 30 cts. per bbl., that it cost nearly 50 per cent. more to take the same train of cars 100 miles by means of oil than by means of coal. Another very potent reason why oil has not and cannot, as we look at it, be used generally for fuel, is found in the following: The total coal consumption of the Pennsylvania Railroad, including all its ramifications, is about 8,000 tons per day. If, now, this fuel consumption was changed from coal to oil, the Pennsylvania Railroad alone would use over 26,000 bbls. of oil per day, and this is over one-third, and at present nearly one-half, of the daily oil production of the United States, so that lack of supply in this country, at least, will, for a long time to come, prevent the use of oil in anything more than a very limited way. In Russia no difficulty of this kind occurs. First, because the oil supply is enormously greater than it is here. Second because the nature of the Russian petroleum is entirely different from American. With the largest portion of American petroleum, 75 per cent. is capable of being made into refined oil, leaving 25 per cent. of residue. In Russia the figures are exactly reversed; 25 per cent. only is made into refined oil, and 75 per cent. is residue, and this residue is what is burned."

As to the possibilities of the future, Dr. DUDLEY expressed the opinion that in this country, so long as efforts were made to restrict the production of oil, it could not be used to any great extent as fuel, though even with present production a limited quantity, say 10,000 or 15,000 bbls. per day might be advantageously used. If changes in the method of distillation were made, so as to produce a special fuel oil, its use as fuel might be increased to some extent.

PUBLICATIONS RECEIVED.

The Railways Terminating in London, with a description of the Terminal Stations and the Underground Railways. By SAMUEL REA, Mem. Am. Soc., C. E. Assistant to Second Vice President, Penna. R. R. Co. New York. 1888, with maps and plans. ENGINEERING NEWS Pub. Co. Publishers. Price, $2.00

This work of Mr. REA should be of great value not only to engineers who are interested in knowing how the intricate problem of railway terminals is solved in London, but of even greater value to bankers, brokers and financial institutions of all kinds that have almost daily dealings in the securities of the roads in question. The work commences with a concise summary of general statistics and comparisons of the railway systems of the United Kingdom. This includes the growth of the roads since 1854, passenger traffic of the various classes, receipts, etc. Then follows a special description of the railways and their termini. These descriptions are from the standpoint of railway management rather than from that of engineering detail. The descriptions give the character of traffic and length of line terminating in any station; the average cost when attainable; the dividend rate paid; passenger traffic handled, connections, etc. This is followed by a short comparison of local and suburban traffic in London and American cities. This comparison shows that the London corporations foster and develop the passenger, and especially suburban passenger traffic, to a greater degree than American trunk lines and that they derive considerable profit therefrom. The author flatly denies the popular statement among American railway managers that "the local passenger traffic do not pay," and advises greater facilities. In a comparison of English and American railway construction Mr. REA says that putting aside any overweening affection for his own country it must be acknowledged that while foreign railways lack many of the conveniences and comforts to the traveller that we are accustomed to, the fact remains that there are some good features on these roads that should have due credit. Among these good points are mentioned the definite laws in England in reference to the formation of new companies; the suppression of level crossings; the superior terminal stations; the almost universal use of the block-signal system, etc. The book concludes with a few suggestions to English railway companies tending towards peace and profit. A close index accompanies this work of 56 octavo pages; and it may be said that there is a rare amount of meat in these pages for the space covered.

CORRESPONDENCE.

Rules for Easement Curves.

ST. HELENA, CAL., Aug. 5, 1888.

EDITOR ENGINEERING NEWS:

The following approximate method of putting in easement curves, which the writer has found very convenient, may be of interest. The method was devised by Mr. A. L. MILLS, now Chief Engineer, Toledo, St. Louis & Kansas City R. R. The calculations are easily and rapidly made, so that any length of easement, and consequently any offset of the main curve from the tangent can be used, and the calculation for each case made in the field. The main curve can be run in as if there were no easement, and then offsetted, or a curve can be run in from a parallel tangent. Tables convenient for use may be made up as in the exact method just published. A short table is given. The length of easement can be changed to suit the ideas of the engineer.

RULES FOR EASEMENT OF CURVES.

For a 2° 45′ to a 3° 30′ curve inclusive, put in 100 ft. of 1° and 100 ft. of 2° curve at each end.

For a 3° 31′ to a 4° 30′ curve inclusive, put in 75 ft. each of 1°, 2° and 3° curves at each end.

For a 4° 31′ to a 5° 30′ curve inclusive, put in 50 ft. each of 1°, 2°, 3° and 4° curves at each end.

For a 5° 31′ to a 6° 30′ curve inclusive, put in 40 ft. each of 1°, 2°, 3°, 4° and 5° curves at each end.

To do this, first run out the uniform curve as if there was to be no easement; then set it in toward its centre, and start back on the tangent the distance given in the table.

The compound points can then be put in by setting off the distances given in the table, measured at right angles to the original tangent.

TABLE FOR USE IN EASEMENT OF CURVES.

Uniform curve to be used.	Amt. to set in the uniform curve towards its center.	Dist. to set back on orig. tangent from P.C. of uniform curve to get new P.C. of 1° curve	Tang. distance meas. from new P.C. of 1° curve on orig. tangent.	Deflection meas. at right angles from orig. tang.	Compound point. Reckoning from the beginning of the curve.
	Feet.	Feet.	Feet.	Feet.	P. C. C.
2° 45′	1.50	90.8	100	0.873	2° 0′
			200	4.36	2° 45′
3° 0′	1.76	100.0	100	0.873	2° 0′
			200	4.36	3° 0′
3° 30′	2.11	114.6	100	0.873	2° 0′
			200	4.36	3° 30′
4° 0′	2.45	112.5	75	0.49	2° 0′
			150	2.45	3° 0′
			225	6.86	4° 0′
4° 30′	2.93	100.0	75	0.49	2° 0′
			150	2.45	3° 0′
			225	6.86	4° 30′
5° 0′	2.17	100.0	50	0.22	2° 0′
			100	1.10	3° 0′
			150	3.05	4° 0′
			200	6.53	5° 0′
5° 30′	2.56	109.7	50	0.22	2° 0′
			100	1.10	3° 0′
			150	3.05	4° 0′
			200	6.53	5° 30′
6° 0′	2.47	100.0	40	0.14	2° 0′
			80	0.70	3° 0′
			120	1.96	4° 0′
			160	4.20	5° 0′
			200	7.70	6° 0′

The calculations are made as follows:

Let d_1 = tangent deflection for the first arc or chord assumed any length and any degree of curvature desired; d_2 = that for second chord, etc. Let 0_1, 0_2, 0_3, etc., = the total lineal deflection from the original tangent to the end of the chords; then the following formulæ will be approximately true.

$0_{1.} = d_1$

$0_{2.} = d_1 + 2d_1 + d_2 = 5\ d_1$

$0_{3.} = d_1 + 2d_1 + d_2 + 2d_1 + 2d_2 + d_3 = 14\ d_1$

$0_{4.} = 14d_1 + 2d_1 + 2d_2 + 2d_2 + d_4 = 30\ d_1$

$0_{5.} = 55\ d_1$

$0_{6.} = 91\ d_1$

$0_{7.} = 140\ d_1$

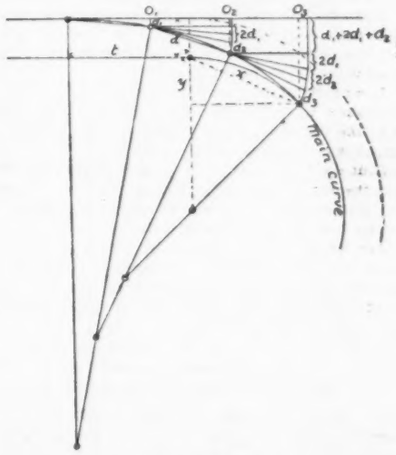
$0_{8.} = 204\ d_1$

$0_{9.} = 585\ d_1$

$0_{10.} = 385\ d_1$

These quantities give the offsets to the easement curve.

Now find the "total curvature each end of main curve," or the curvature in the easement curve. The ratio between this curvature and the degree of the main curve gives the distance from the *P. C.* or *P. T.* of the main curve as offsetted to the point



Easement Curve.

where the easement joins the main curve, and is equal to x. Length of easement $= x = t$. When the main curve is a full degree curve as $4_{0.}$, $5_{0.}$ etc., $x = t$.

y = tangent deflection on main curve for the distance x.

$y - o = d$ = distance to set the main curve in towards its center, or distance to offset the tangent to run in the main curve if this is deemed preferable.

EXAMPLES.

Main curve 5° 0′; easement changing 1° 0′ for each 30 ft.

	Feet.
$d_1 = 0_1 = .873\ n^2\ D = .0786 =$	0.08
$0_2 = 5d_1 =$	0.39
$0_3 = 14d_1 =$	1.10
$0_4 = 30d_1 =$	2.36

Total curvature in easement curve = 3° 0′.

3° 0′ curvature on a 5° 0′ curve = 60 ft. distance.

Total length of easement = 120 ft.

120′ − 60′ = 60′ = t.

Tangent deflection 5° 0′ curve for 60 ft. = 1.57 ft.

$0_4 = 2.36$ ft. 2.36′ − 1.57′ = 0.79′ = d.

This agrees closely enough with the result obtained in the paper just published.

Main curve 20° 0′; easement curve changing 2° 30′ to each 30 ft.

$0_1 = d_1 = .873\ n^2\ D =$	0.1964
$0_2 = 5d_1 =$	0.98
$0_3 = 14d_1 =$	2.75
$0_4 = 30d_1 =$	5.89
$0_5 = 55d_1 =$	10.80
$0_6 = 91d_1 =$	17.87
$0_7 = 140d_1 =$	27.50

Total curvature in easement curve = 21° 0′.

21° 0′ curvature on a 20° 0′ curve = 105 ft. distance.

Total length of easement = 210 ft.

210′ − 105′ = 105′.

Tangent deflection 20° 0′ curve for 105 ft. = 19.10 ft.

27.50′ − 19.10′ = 8.40′ = d.

Suppose it is desirable to move a 10° curve in 5 ft. from the tangent, and put in an easement curve 200 feet long.

As the curve is a full degree curve $x = t$ ∴ x = 100 ft. Tangent deflection for 10° curve for 100 ft. = 8.72 ft.. 8.72 + 5 = 13.72.

If points on the easement are desired every 25 ft. then 0_n will be the last offset.

$0_n = 204\ d,\ = 13.72\ .'.\ d,\ = 0.0672'.$

The other offsets can now be readily determined.

If the change of curvature for each 25 ft. is desired it can be approximately found as follows. It is not necessary in laying out the easement.

$$d, = .873\ n^2\ D = .0672\ .'.\ D = \frac{.0672}{.873 \times .25^2}$$

HERBERT A. YOUNG.

Rock-filled Dams.

BINGHAMTON, N. Y., Aug. 14, 1888.

EDITOR ENGINEERING NEWS:

My experience of many years in maintaining rough dams has caused me to think out much the same conclusions that you come to on rock-fill dams.

It has also caused me to believe there is a feature in masonry dams not sufficiently considered by engineers, viz. that only so much of the mass as is below, (*i. e.* down stream form,) the plane of greatest tightness or resistance to the passage of water, is of value in sustaining the dam.

In your "rock-fill dam", all the mass is useful, because the water pressure is sustained at the inner surface; any water passing through that, flows away without exerting any more pressure.

On the other hand a masonry dam may be so built, and probably usually is so built that the lightest vertical course is somewhere within the mass, or even at the very outer face.

In reading the accounts of the failure of the dam near New Brunswick, N. J., I noticed that they had recently been plugging and pointing the outer face of the dam, with the idea of tightening it—the very thing to ensure its failure.

JOSEPH P. NOYES.

SOCIETY PROCEEDINGS.

New England Roadmasters' Association.—The sixth annual convention of the Association was called to order at the United States Hotel, Boston, Mass., at 2.30, P. M., Aug. 15, by President J. S. LANE.

The Chaplain being absent, the usual devotional exercises were conducted by E. NEWCOMB. President LANE delivered a brief address in which he reviewed the work of the past year on the New England roads, and traced briefly the rise of the railway systems, prophesying in closing that the steel rails and wooden ties of the present day would be replaced in the near future with rails weighing 100 lbs. per yard, or heavier, laid with steel ties. This with the abolition of Sunday work, would effect a great change in the roadmasters responsibilities.

The roll call showed 18 members present. This number was largely increased before the afternoon closed by the arrival of the more distant members.

The election of officers, which was next in order, resulted as follows:

J. R. PATCH (Conn. Riv. R. R.), President.
G. W. BISHOP (Fitchburg R. R.), Vice-President.
E. NEWCOMB (Portland & Ogdensburg R. R.), Chaplain.
W. F. ELLIS (Providence & Worcester R. R.), Secretary.
GEO. NEVENS (Maine Central R. R.), Treasurer.
F. C. CLARKE (Housatonic R. R.), J. W. SHANKS (New London Northern R. R.), and L. H. PERKINS (New York, New Haven & Hartford R. R.), Executive Committee.

The Association then began the discussion of the subjects which were announced in last week's issue, taking up first, the economy of maintenance of highway crossings. The report of these proceedings will be given next week.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

South Norfolk—

SIMCOE, ONT., Aug. 8, 1888.

EDITOR ENGINEERING NEWS:

The South Norfolk Railway is to run from Simcoe, Ont., to Port Rowan on Lake Erie, a distance of 17 miles, passing through Victoria, Forestville and St. Williams. On the first three miles from Simcoe, the work involves some heavy clay cuts and fills. For the balance of the distance the soil is sand with only one heavy cut and fill. Right of way is secured with the exception of five cases where arbitration is necessary, and the work of construction began July 23d, being done directly by the company. ALEX. MCDONNELL, of Toronto, is Superintendent of Construction. The line will probably be ready for the rails in about two months, and will be completed by Nov. 15, 1888. E. DALY is Chief Engineer. The line is in the interest of the Grand Trunk Railway Company.

A. MCALL, *President.*

Western New York & Pennsylvania.—It is announced that this company, which is the successor of the Buffalo, New York & Philadelphia, is to let contracts at once for an extension of the branch which now terminates at Clermont, Pa., to Johnsbury, on the the Philadelphia & Erie, a distance of 20 miles. R. D. MCCREARY, of Buffalo, is Chief Engineer.

Toledo, Saginaw & Mackinaw.—This Michigan road, which was graded last season from Durand to East Saginaw, a distance of 50 miles, will probably be open for traffic by Sept. 15. About 35 miles of track are now laid. Local opinion is divided as to whether the road will form part of the Grand Trunk system, or the Toledo, Ann Arbor & North Michigan. The managers of the latter company say:

"We have not made any arrangement with the Saginaw & Durand Company, which controls about 70 miles of road, and we are not yet in position to speak concerning the probability of our making one. At all events, the road will be a valuable feeder."

Cooperstown & Charlotte Valley.—Grading is well advanced on the extension four miles in length from Cooperstown Junction, N. Y., to connect with the Ulster & Delaware extension.

Baltimore & Ohio.—The surveys have been completed for the branch from the Central Railroad of New Jersey, near Roselle, to the Arthur Kill Bridge. The work on the line is light and it can be rapidly built. If the Reading Company lives up to its traffic contracts, the coveted terminus of the Baltimore & Ohio system, on Staten Island, will soon be a reality.

Canadian Pacific.—The International Railway, which is being extended through the State of Maine, is now operated as part of the Ontario & Atlantic division, of which A. MCKINNON is General Superintendent.——The final surveys are in progress along the London and Windsor extension.——It is reported from various sources that one of the most important allies and connections of the Canadian Pacific, at no distant day, will be the Wabash.

Cincinnati Northern.—CHARLES RAYMOND has brought suit against the stockholders of this company to recover damages to the amount of $290,000, being the sum paid for bonds of the Cincinnati, Avondale & Spring Grove Company.

Black Diamond System.—We acknowledge the receipt of a map of this projected system of roads which is intended to develop the coal regions of southern Ohio and West Virginia. The system includes the Zanesville, Mt. Vernon & Marion—main line Zanesville to Marion, 92 miles, with 48 miles of branches; the Painesville, Wooster & Ohio—Zanesville to Richmond, O., 200 miles; the Virginia, Parkersburgh & Ohio—Parkersburgh, W. Va., to Clifton Forge, Va., with branch to Charleston, 360 miles; the Zanesville & Ohio River and Shawnee & Muskingum River roads, now in operation from Zanesville to Harmar, Shawnee to Sherwood and Buckingham to Sedalia, 120 miles. ALBERT E. BOONE, of Zanesville, is the principal promoter of the enterprise, which has been under way for two or three years.

Pennsylvania.—The company proposes to extend the East Brandywine & Waynesburg Railroad from its terminus at New Holland, Pa., to Lancaster.

Lehigh Valley.—The *Financial Critic* publishes a report that the company has made a contract with the New York, Lake Erie & Western, for the joint use of the Erie tracks, on the Buffalo and the Susquehanna divisions. The Lehigh Valley will pay the Erie 3 per cent. annually on the appraised valuation of the lines, and share equally in the expense of maintenance. If true, this is a wise move on the part of the Lehigh Valley, and is much to be preferred over the scheme for building an independent line to Buffalo, as the existing lines are ample for the traffic.

New Projects and Surveys.

Rome & Carthage.—This company has filed articles of incorporation in New York, with a capital stock of $600,000. The incorporators include G. V. SELDEN, JAS. C. SMITH, and JOHN R. EDWARDS, of Rome, CHESTER RAY, of Martinsburgh and M. P. MASON, of Carthage. The line was surveyed last Fall from Rome to Carthage, N. Y., a distance of 56 miles, and subscriptions have been made to the capital stock sufficient to permit of the filing of the articles of incorporation.

Chicago, Dayton & Cincinnati.—This company has been voted aid to the amount of $33,400, by the city of Bluffton, Ind.

Adamsdale & Walpole.—A survey is in progress for a railroad between these Rhode Island towns.

Elkhart & Western.—E. C. BICKEL, of Elkhart, General Manager of this company is obtaining right of way for this road from Elkhart to Mishawaka, Ind., a distance of 11 miles. Work is very light for the whole distance; the main expense will be the construction of a bridge across the St. Joseph river.

Evansville & Terre Haute.—H. KURTZ, attorney for the MACKEY system, is securing petitions for calling an election to be held at Columbus, Ind., on Oct. 2, to vote a two per cent. tax and $75,000 to aid in the extension of this road from Elnora to Columbus, Ind.

Freehold & Seabright.—A railroad is projected from Freehold to Seabright, N. J. The principal movers in the enterprise are New York business men, who have summer residences at Seabright. The road would be about 17 miles in length.

Columbus, Lima & Northwestern.—The company has asked the city of Kalamazoo, Mich., for the right of way and $3,000 per mile, in aid of its proposed line through that city and county.

Washington & Western Maryland.—The House Committee, on the District of Columbia, have reported favorably a bill to incorporate this company, which has already been chartered in Maryland, and proposes to build a railroad from Washington to Williamsport, Ind.

Amsterdam & Gloversville.—A company has been formed to build a railroad between these New York towns.

Vincennes, Oakland City & Owensboro.—The directors have voted to let the contract for the construction of this Indiana road at Boonville, Ind., on Sept. 3. It is not stated whether capital for construction is secured. JAS. C. RUDD, of Owensboro, Ky., is President

SOUTHERN

Existing Roads.

Mt. Pleasant & Seaview City.—

CHARLESTON, S. C., Aug. 8, 1888.

EDITOR ENGINEERING NEWS:—

The Mt. Pleasant & Seaview City Railroad is to run from Charleston, *via* Mt. Pleasant and Moultrieville, to Seaview City, S. C., a distance of 7 miles, besides 1 mile of ferry from Charleston across Cooper river. There is 1¾ miles of trestle bridging, the rest is light grading. The contract has been let to IRA L. WILLITS, P. O. Box 635, New York City, for the building of the line. The road is to be constructed and equipped by him for $150,000 in stock and bonds, the line to be completed by March, 1889. Work is now in progress. JOHN BRADLEY is Superintendent of Construction, and S. LEWIS SIMMONS is Chief Engineer.

The road was projected to connect Charleston with its only summer resort. In the spring there will be a heavy garden truck traffic from Mt. Pleasant, amounting now to $14,000 in two months, but will be greatly stimulated by the building of the road. The whole of Seaview City, 600 acres in extent, was granted by the Legislature of South Carolina, as a subsidy to this company. It will be improved and developed to make the finest seaside resort on the Atlantic coast. The beach is 100 yds. wide and is unsurpassed for bathing.

R. C. GILCHRIST, *President.*

Atlanta & Florida.—AARON HAAS was elected President of this new Georgia line to succeed the late JOHN N. DUNN at the recent directors' meeting. P. O. PRONG was elected Superintendent. The following resolution was unanimously adopted:

Resolved, That the president of this company is authorized to place a surveying corps in the field at once for the purpose of locating the extension of the Atlanta & Florida southward.

One preliminary survey has already been made on a line from Fort Valley to Thomasville. Track is now laid to within one-half mile of Fort Valley. The Georgia Improvement Co. has an option on the contract for building the extension of the Atlanta & Florida road. In the event that this company fails to take advantage of its option, bids will be advertised for. The Georgia Improvement Co. has a large interest in the Atlanta & Florida, and it is to be presumed will accept their option and continue as contractors in its extension.

Louisville Southern.—The Midway & Georgetown extension, of which J. H. PEARSON is Chief Engineer, will be open for business before Oct. 1. Tracklaying is to begin at once.

Decatur, Chesapeake & New Orleans.—Ground was broken on this road near Shelbyville, Tenn., on Aug. 8, and construction is now in progress under direction of G. W. EDWARDS.

Monte Sano.—

HUNTSVILLE, Ala., Aug. 9, 1888.

EDITOR ENGINEERING NEWS:—

The Monte Sano Railroad is the name of a new road connecting Huntsville on the M. & C. R. R. with the top of the famed Monte Sano. Monte Sano is 1,700 ft. above sea level and 1,100 ft. above the Big Spring in Huntsville, and was used as a refuge for the yellow fever sufferers from Memphis and surrounding towns during the epidemics in those places. It is also a famous health resort. The preliminary and location surveys were made by the writer under the direction of ARTHUR OWEN WILSON, who has had charge of almost all the independent mountain railroad work in the Birmingham district for over two years past. The route selected out of six different ones submitted by the writer, was the one starting from the M. & C. R. R. depot and thence through Huntsville to East Huntsville and by a gradual ascent to Fagin's Cove, where, by a button-hole curve, it turns back and climbs the rocky sides of the mountain on a bench cut out for it from the solid rock. The total length of the road is 8½ miles and its maximum grade 4 per cent. The surveys were finished on July 4, and the contract was signed immediately for the completion of the road by Sept. 1, 1888. We are at present engaged in laying the track on the first 3 miles, and I have no doubt but that the contractor will be able to turn it over at the stated time. The officers of the railroad company are: W. K. P. WILSON, President, and ARTHUR OWEN WILSON, Secretary, Treasurer and Chief Engineer.

THOS. F. O'BRIEN.

Natchez, Jackson & Columbus.—The city of Natchez Miss., has voted $225,000 to this company toward the expense of changing the line from narrow to standard gauge. There were 864 votes for the subsidy and only 10 against it.

Nashville, Chattanooga & St. Louis.—The grading has been completed for the change of gauge on the Duck River Valley Narrow Gauge Railroad, and the rails have been spread between Fayetteville and Pittsburg, Tenn. Piers have been built for an iron bridge over the Columbia river between Columbia and Lowisburgh, Tenn.

Georgia, Carolina & Northern.—Contracts are being let for the division between Chester, S. C. and Athens, Ga., and the grading is to be pushed this fall.

Savannah, Dublin & Western Short Line.—It is reported that a syndicate, of which Col. R. J. DAVANT of Savannah, is one of the members, proposes to take hold of this enterprise and complete it as originally planned. It is generally supposed that the Central Railroad of Georgia holds enough of the company's obligations to prevent any attempts of this sort from attaining success.

Louisville, New Orleans & Texas.—The contract for the construction of the Bolivar branch, reported last week, has been let to J. S. McTighe & Co., of Memphis, Tenn., who will sublet the work.

Central Railroad of Georgia.—Work is to begin soon on the extension of the East Alabama railroad to Wedowee, 20 miles from its present terminus at Roanoke.

Northwest & Florida.—Work is in progress on the extension of this road (formerly the Montgomery & Florida) to Luverne, Ala.——It is probable that the line will be altered to standard gauge.

Seaboard & Roanoke.—It is reported that the Scotland Neck branch in North Carolina is to be extended to Greenville and Kinston with a possibility of a further extension to Jacksonville, Inslow county.

St. Cloud Sugar Belt.—This Florida road is making rapid progress, and the contractors expect to complete it by Sept. 15.

New Projects and Surveys.

Brunswick & Atlanta.—

BRUNSWICK, Ga., Aug. 6, 1888.

EDITOR ENGINEERING NEWS:

Nothing has yet been done under the charter of the Brunswick & Atlanta. It is possible that railroad developments will obviate the necessity for the construction of this road. C. P. GOODYEAR, *Incorporator.*

Leesburg & Lake Region. J. F. RICHMOND of Okahumpka, Fla., has been chosen president of this company.

Chattanooga, Hiawassee & Augusta.—This company is securing local subscriptions along its proposed line.

THE NORTHWEST.

Existing Roads.

Chicago & Northwestern.—The new extension in the North Michigan peninsula from Ishpeming to Michigamme and Republic has been completed and opened for traffic.

Duluth, South Shore & Atlantic.—A press report from Marquette, Mich., states that the Northern Pacific will refuse to grant the company a trackage right over its lines from Ashland to Duluth and that Chief Engineer J. A. LATCHA has been instructed to push the work at once on the extension to Duluth.

Winona & Southwestern.—Foley Bros. and Donald Grant & Co., the contractors on the first division of this road are establishing their grading camps along the line and transferring men and teams to the scene of operations. It seems entirely probable that grading all along the line from Winona to Omaha would now be well advanced had it not been for the recent railway legislation in Iowa.

St. Paul, Minneapolis & Manitoba.—The Winona, Minn., *Republican* gives the following account of the work on the Duluth extension on which Foley Bros. have just completed the grading and bridging.

The line for the entire distance runs through a dense pine forest, the ground being of a wet and swampy character along nearly the entire route. The men and teams worked in the mud and water the whole time, as a piece of dry footing was a thing unknown. In order to labor at all it was often found necessary to construct ditches miles in length, and in some instances 15 ft. deep. In one fill 70,000 yds. of dirt were used. It was necessary to build "corduroy roads" along the whole line, for the soil was such that, even on the tops of hills, the teams would mire after a few hours use of the roads. The 100 ft. right of way yielded 5,000,000 ft. of lumber. When it was cleared it looked like a cut through an immense snow drift, with sides resembling stone walls in uniformity. The bridge over Kettle river is very high, the distance from the water to the rails being 140 ft. The bridge over Nemadji river is about 1¼ miles long and contains 1,500,000 ft. of lumber, far more than any other bridge in the State. The average number of men employed was 3,500. This large force was divided into night and day relays, and the work was prosecuted day and night. Four hundred car loads of supplies were necessary for this force of men and animals, of which 80 were hay and the same number oats and corn. Old and experienced railroad contractors expressed the opinion at the start that Foley Bros. could not complete the work this year, and the company offered them $200 per day for every day the grading was finished before October 1, providing they would forfeit $100 per day after that date. The contractors declined. As the grading was completed July 1, Foley Bros. would have been $18,000 ahead if that provision had been in.

Chicago, Milwaukee & St. Paul.—Surveys are in progress for the extension of the Evanston division to Highwood, Ill.

Winona & Southwestern.—The first sod was turned on this road at Winona, Minn., on Aug. 11, by Mayor LUDWIG of Winona. The day was celebrated by the city as a public holiday.

New Projects and Surveys.

Norfolk & Yankton.—Right of way is being secured for a railway from Norfolk, Neb., to Yankton, Dak. Yankton citizens are said to be subscribing heavily to the scheme.

Pana & Roodhouse.—The company to build this projected line from Pana to Roodhouse, Ill., about 75 miles was incorporated about 18 months ago and did considerable work in obtaining right of way. The enterprise is still being agitated and estimates of the cost of construction are being made. The headquarters of the company are at Pana.

Waterloo & Belle Plaine.—A project is on foot for a railroad between these Iowa towns, if the Waterloo correspondent of the Chicago *Tribune* is to be relied upon. It is not stated what philanthropist is to furnish the money to build railroads in a State where the people seem to have an idea that a railroad is making money enough when its receipts are sufficient to pay its operating expenses.

THE SOUTHWEST.

Existing Roads.

Gulf, Colorado & Santa Fé.—The construction train on the extension from Ballinger, Tex., to San Angelo reached the latter city on Aug. 6. The road is now being operated by the contractors, Ricker, Lee & Co., of Galveston, and will be turned over to the Santa Fé company about Sept. 1.

Missouri Pacific.—A corps under WILLARD BEAHAN is engaged on the locating survey of the Jefferson City & Southwestern extension from Carthage to Bagnell, Mo. Preliminary surveys for the line were made last season.——The Interstate Railroad Construction Co., has been incorporated in Colorado with C. C. THOMPSON, of Chicago, J. D. BOWERSOCK, of Lawrence, Kan., D. P. MARSH, of Omaha, Neb., and GEO. H. CLARK, of Kansas City, and others, as incorporators. The object of the company is supposed to be the construction of the Interstate Railway, incorporated last season in the Missouri Pacific interest to build a railroad from Madison, Kan., to Denver, Col.

Texas Pacific.—It is reported that a branch is to be built from Plaquemine, La., to Bayou Plaquemine, about 9 miles in length. Surveys have been made.——A correspondent of the London *Financial News*, who has been making a trip over the line, gives a graphic account of its past financial history, but reports a heavy traffic and every prospect that the road is destined to enjoy a prosperous future.

Union Pacific.—Surveys are in progress for a branch of the Utah & Northern from a point near Eagle Rock to the Yellowstone National Park.——Three preliminary surveys have been made from Robinson to Red Cliff, Col.——It is stated that the company intends to build into northern Idaho at an early date; but whether *via* the Salmon or Snake valleys is not yet decided.——The Lincoln & Colorado extension was completed to Plainville, Kan., on Aug. 10.

Oregon Pacific.—The contract for completing the unfinished division, 30 miles in length, abandoned by contractors Hunt and Bennett last season, has been let to Brinck & West, and work was begun by them on Aug. 13, with a force of 500 Chinamen.

Oregon Ry. & Nav. Co.—J. H. Smith has a sub-contract for 20 miles of the Cœur d'Alene extension under Kilpatrick Bros. & Collins, and has advertised for 1,000 hands to work on the line.

St. Paul, Minneapolis & Manitoba.—The Spokane Falls, W. T., *Chronicle* claims to know that the plans of the company are all matured for the construction of an extension from Butte City, Montana, *via* Anaconda Phillipsburg, and Missoula to Spokane Falls, there to connect with the Seattle, Lake Shore & Eastern. Other, and presumably more reliable authorities, deny this story, and it seems altogether probable that the Manitoba will not make any very rapid moves toward the Pacific this year.——A press despatch from Great Falls, Montana, states that the surveys are to begin at once for a branch to the Belt Mountain mineral region, a distance of about 50 miles.——The Wickes tunnel, on the Montana Central between Helena & Butte, will be completed about Sept. 1. Trains are running over the Northern Pacific tracks until its completion.

New Projects and Surveys.

Brazos River.—The Houston, Tex., *Post* of Aug. 7, contains the following:

Mr. G. W. Angle, of San Antonio, Tex., agent for the syndicate that proposes to secure deep water at the mouth of the Brazos, was in the city yesterday, but left last night for New York. In that city a consultation with the New York and Boston capitalists interested in this project will be held, and they will then proceed to Chicago, where a meeting will be held on the 20th prox. At this meeting organization will be effected and arrangements for commencing work in the fall will be made. The syndicate will, however, build a railroad from the mouth of the Brazos to this city, and work on this will be commenced as soon as a charter is obtained. The railroad will be built first from the Brazos to connect with the Columbia tap, but it will ultimately be continued to this city.

St Louis, Hannibal & Omaha.—E. M. COLLINS, of Kirksville, Mo., is to make surveys for the proposed line from Hannibal, Mo., to Omaha, Neb.

Leavenworth & Rio Grande.—This company has filed a charter in Kansas, and proposes to build a railway from Leavenworth through various Kansas counties, the Indian Territory and Texas; to a suitable point on the Rio Grande river. C. A. BURNS, of St. Joseph, E. C. POST and R. H. BOSTWICK of Atchison, Kan., are among the incorporators.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Arizona & Southeastern.—

FAIRBANKS, Ariz. Ter. Aug. 6, 1888.

EDITOR ENGINEERING NEWS:

The Arizona & Southeastern Railroad will run from Fairbanks to Bisbee, Arizona, a distance of 37 miles. Ward & Courtney have the contract for grading, and H. P. Selden the contract for bridging, the work to be completed Oct. 1. Tracklaying will begin about Aug. 10. The road is independent of existing lines, and will do a general traffic business. J. DOUGLAS is President of the company. M. W. WAMBAUGH, Chief Engineer.

Northern Pacific.—The difficulty between the company and the Seattle, Lake Shore & Eastern, in reference to the respective route of the lines in the Grand Coulee, Washington Territory, was amicably settled by the chief engineers of the two companies, who made mutual concessions to permit both lines to be satisfactorily located. This is an example which is well worth imitation in other localities, and would result to the advantage of all parties concerned.——It is reported that a conference was held with gratifying results, between HENRY VILLARD and President ADAMS and other prominent officers of the Union Pacific, with the purpose of settling all rivalries over the occupancy of new territory on the Pacific coast, including the present suit over the joint lease of the Oregon Ry. & Nav. Co.

Denver & Rio Grande.—The double tracking is to be undertaken this Fall of the line from Denver to Littleton 10 miles; from Colorado Springs north, 10 miles; and from Pueblo north, 19 miles.

Seattle, Lake Shore & Eastern.—Grading is about finished on the eastern division from Spokane Falls to Davenport, W. T. Tracklaying, however, is delayed until a connection can be made with the Northern Pacific tracks at Spokane Falls.——An interview with Vice-President D. H. GILMAN regarding the Seattle & West Coast extension to the boundary contains the following:

"Mr. Van Horne, Vice-President of the Canadian Pacific Railroad Co., called on me in New York in May last, and we then agreed upon a basis of connection between our northern branch and the Canadian Pacific main line. On June 5, Mr. Van Horne notified me by letter that the Canadian Pacific Board of Directors had that day ratified the agreement that we had made and passed a resolution that they would meet us at the boundary line and undertake to have their line ready by the time we could extend ours to the boundary.

"By this arrangement we are to extend our line north to the boundary and the Canadian Pacific is to build from Vancouver south to the boundary, passing through New Westminster. Both companies agree to have their respective lines completed to the point of connection during the year 1889. Our line is located to the Skagit river and we have an engineering party in the field beyond that point. The Canadian Pacific has a party in the field on its portion of the line under Mr. H. J. Cambie. By an arrangement between Van Horne and myself the engineers of the two companies will meet at the earliest possible day and fix on the point of connection on the international boundary line."

New Projects and Surveys.

Mt. Hood & Eastern.—Incorporated in Oregon by R. P. EARHART, D. C. MCKERCHER and W. A. BAUTZ, with a capital stock of $2,000,000. The line is to be built from Portland, Ore., through the Salmon River pass of the Cascade mountains to a point near the mouth of the Owyhee river in Malheur county. A preliminary survey of the route has been made, running close by the base of Mt. Hood.

Seattle & Southern.—Incorporated at Seattle, W. T., with a capital stock of $7,000,000 to build a railroad from Seattle to Portland, Ore., a distance of 160 miles.

Lethbridge & Fort Benton.—This line, of which Sir A. T. GALT of Montreal is the chief promoter, is projected from Lethbridge, N. W. T., to Dunmore and thence to Fort Benton and Billings, Montana. Ties are already being collected along the line.

New Westminister, Bellingham Bay & Seattle.—This is the name of the consolidated Bellingham Bay Ry. & Nav. Co. and the New Westminister Southern Ry. Co. EUGENE CANFIELD, of Seattle, W. T., is the chief promoter of the enterprise. A large bonus has been voted by New Westminister and construction will probably begin at once.

San Diego & Phœnix.—A project is under consideration at San Diego, Cal., for a railroad due east to Phœnix, Arizona. At a meeting of prominent citizens held in the Camber of Commerce building, a committee was appointed to go to Phœnix and confer with the business men there in reference to the project.

Proposals Open.

Bridges.—At First St., to cost $65,000; and at Seventh St., to cost $12,000. THE CITY CLERK, Los Angeles, Cal.

Sewer Work.—For the removal of about 200,000 cu. yds. of earth, laying about 4,700 lin. ft. of sewer pipe, and 2,100 cu. yds. of brick work for sewer. Plans and specifications on file. JULIUS H. PITZMAN, Chief Engineer, Catlin Land & Improvement Co., St. Louis, Mo. August 20.

Street Work.—Paving alleys. O. N. GARDNER, City Engineer, Lincoln, Neb. August 20.

Sewers.—On Central St., at Central Falls, R. I. THE TOWN CLERK, Lincoln, R. I. August 20.

Sewers.—About 1,045 ft. of 28 × 42-in., and 112 ft. of 36 × 57-in. brick sewer. Material furnished by the Board

of Public Works. SAMUEL M. GRAY, City Engineer, Providence, R. I. August 21.

Street Work and Sewers.—The COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. August 21.

Sewers.—PERCIVAL W. ST. GEORGE, City Surveyor, Montreal, Canada. Aug. 22.

Concrete, Sewers, Track, Etc.—At the Hospital for the Insane. Sewers, concrete floors, railroad track etc. Architects, JACOB LENZEN & SON, San Jose. L. G. NESMITH, San Jose, Cal. August 23.

Piers and Culverts.—Masonry piers and culverts on Sections 16 to 23 inclusive. Plans and specifications with H. DOUGLAS, Resident Engineer, near Georgetown, Ky. W. M. PATTON, Kentucky Midland Ry. Co., Georgetown, Ky. August 25.

Railway.—Chowan & Southern Ry. From Drivers, Nansemond Co., Va., to Tunis, on the Chowan river, in Hertford Co., N. C., 36 miles; and from near Roxobel, N. C., to Tarboro, N. C., 27 miles. With the exception of approaches to the Chowan and Roanoke rivers, the work consists principally of light embankments. G. M. SERPELL, General Manager, American Construction Co., 100 Main St., Norfolk, Va. August 25.

Well.—Proposals for sinking a well about 1,200 ft. deep for natural gas. Well to be used for water supply if gas is not discovered. G. H. SUNDMACHER, City Attorney, Murphysboro, Ill. August 25.

Filling.—Dirt filling in W. 12th St. Bids per cubic yard for black soil and common filling. CUTHBERT MCARTHUR, Secretary, West Chicago Park Commissioners, Washington Boulevard and Halsted St., Chicago, Ill. August 27.

Jetty.—Repairing brush and stone jetty at Sand Island light station, Mobile Bay, Ala. Amount available, about $9,000. Capt. W. L. FISK, U. S. Lighthouse Engineer, New Orleans, La. August 29.

Court House and Jail.—Plans and specifications on file. A. F. Ross, Clerk of County Supervisors, Redding, Shasta Co., Cal. September 3.

Railway.—JAS. C. RUDD, President, Vincennes, Oakland City & Owensboro Ry., Boonville, Ind. September 3.

Sewers.—Pipe sewers; 5,780 ft of 10-in ,10,450 ft. of 12-in., 23,620 ft. of 15. in., 270 ft. of 18-in., 1,025 ft. of 21-in., 12,545 ft. of 24-in ; 133 manholes, 70 catch basins, 100,000 lbs. of castings. C. W. BRININGER, City Clerk, Grand Island, Neb. September 5.

Electric Light Plant.—For State Prison at Marquette, Mich. Architects, SCOTT & CO., Wayne County Bank Building, Detroit, Mich. E. P. ROYCE, President, Board of Commissioners, Marquette, Mich. September 5.

Contracting.

The American Granite Co., of Chicago, Ill., has been incorporated by ORLANDO M. DOTY, SYLVESTER MARSHALL and W. B. STONE. Capital stock, $500,000.

Cross Ties.—Whitaker & Co., of Texarkana, Ark., have a contract for 100,000 cross-ties for the Texarkana & Northern R. R.

Thornton & Glenn, of Birmingham, Ala., have a contract for 55,000 cross-ties for the extension of the Birmingham Mineral R. R.

The California Bituminous Block Mfg. Co. has been incorporated by H. DUTARD, A. HALSEY, W. C. WATSON and A. JUDSON, of San Francisco, and M. B. POND, of Napa. Capital stock, $2,000,000.

Metal Ties.—The National Metallic Railway Tie Co. has been incorporated at Camden, N. J., with a capital stock of $25,000.

The Benton Iron Co. has been incorporated at Benton, Col., by G. W. CAMPBELL, H. L. SUTTON, J. H. CURTIS and J. E. BLYTHE, to deal in real estate, build street railways, water-works, etc. Capital stock, $10,000. There will be a branch office at St. Louis, Mo.

The California Hydraulic Dredging & Reclamation Co. has been incorporated by HIRAM L. COYE, CHAS. L. HASKELL, MARCUS D. HYDE, and others. Capital stock, $600,000.

Street Railway.—The contract for the construction of the electric railway at Bangor, Me., has been awarded to Gore & Co., of Boston, Mass.

Bridges & Trestles.—Hoffman & Bates, of Portland, Ore., have the contract for building bridges and trestles on the Oregon Railway & Navigation Co.'s line from Farmington to Mullan.

Sewers.—*Washington, D. C.*—The following contracts have been awarded by the District Commissioners: J. J. Cudmore; 12, 15 and 18-in. sewers, 80 cts., 86 cts. and 99 cts. per lin. ft. B. F. Beach; 20, 21 and 24-in. sewers, $1.19, $1.19 and $1.25 per lin. ft. Andrew Gleason; 2 ft. x 3 ft., $2.21 per lin. ft.; 2.25 x 3.37 ft., $2.48; 2.5 x 3.75 ft., $2.59; 2.75 x 4.12 ft., $2.48; 7.64 ft. diameter, $8.35 per lin. ft. P. Maloney, 3 x 4.5 ft., $3.90. M. Hines, receiving basins, $47.

Water-Works Improvements.—*Brooklyn, N. Y.*—Mayor CHAPIN, City Works Commissioner ADAMS, and Corporation Counsel JENKS, after a long consultation, have decided to advertise for proposals for making the water supply improvements at Ridgewood. About $500,000 will be needed for the new work.

River Improvement.—The following proposals for building coffer-dam, excavating lock-pit, and constructing Lock No. 1, Cumberland river, were opened Aug. 7, by Lieut.-Col. J. W. BARLOW, U. S. Engineer Corps, Chattanooga, Tenn. The contract for coffer-dam and excavation was awarded to H. F. Holmes & Phil. Wilk, Jr., of Nashville, Tenn., for $15,755; the contract for masonry, etc., for lock was awarded to Whitsit & Adams, of Nashville, Tenn., for $39,700.

Bidders.	Coffer-dam. 600 lin. ft.		Excavation for Lock Pit.				Lock Construction. Masonry.							
	Per lin. ft.	Amt.	*a* Per cu yd.	*b* Per sq. ft.	*c* Per cu. yd.	Amt.	*d* Per cu. yd.	*e* Per cu. yd.	*f* Per cu. yd.	*g* Per cu. yd.	*h* Per cu. yd.	*i* Per lin. ft.	Amt.	Total.
	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Hughes & Gayner, Syracuse, N. Y.	8.00	4,800	.40	1.00	1.90	20,330	10.50	15.50	17.00	22.00	40	.75	55,725	80,855
Hong & Petitdidier, Pittsburg, Pa	23.00	13,800	1.00	.27	3.49	37,343	9.00	13.00	15.00	17.00	25	.67	49,867	101,010
H. F. Holmes & P. Wilk, Jr., Nashville, Tenn	5.75	3,450	.50	.30	1.15	12,305	8.25	11.00	12.00	14.50	30	1.50	41,325	57,080
Whitsit & Adams, Nashville, Tenn	8.00	4,800	.60	.30	1.60	17,120	7.60 15.40	11.25 16.40	12.00 17.45	12.50 18.75	40 27	2.00 1.00	39,700 67,360	61,620 82,200
D. McDonald, Louisville, Ky	15.00	9,000	.50	.40	1.20	12,840	13.75	14.70	—	—	—	—	—	—

a, Earth deposit, if any; *b*, Natural rock, in place, if any; *c*, Rock in place, 10,700 cu. yds.; *d*, Backing, 2,500 cu. yds.; *e*, Rock face, 600 cu. yds.; *f*, Pointed face, 700 cu. yds.; *g*, Bush hammered face, 200 cu. yds.; *h*, Quoins, 40 cu. yds.; *i*, Bolt holes, 100 lin. ft.

Water-Works.—*Sutton, Neb.*—The following contracts have been awarded: Tamaqua Mfg. Co., Tamaqua, Pa., hydrants and valves; Cook Well Co., St. Louis, Mo., well and machinery; Addyston Pipe & Steel Co., Cincinnati, O., pipe and specials; A. L. Metcalf, Lincoln, Neb., buildings. A. A. RICHARDSON, of Lincoln, Neb., is the Consulting Engineer.

Pipe.—The following proposals for cast-iron water pipe have been received by GEO. B. SWIFT, Commissioner of Public Works, Chicago, Ill. The quantities required were 12,000 pieces of 6-in., 6,000 of 8-in., 2,000 of 12-in., 1,500 of 16-in., and 200 of 24-in. R. D. Wood & Co., Philadelphia, Pa.; 6-in., $24.94; 8-in., $24.84; 12-in., $24.70; 16-in., $24.60; 24-in., $24.40 per ton; $170,248.60. Addyston Pipe & Steel Co., Cincinnati, O., $24.85 per ton for all sizes, $170,595.25. Shickle, Harrison & Howard Iron Co., St. Louis, Mo., $26.50 per ton for all sizes, $181,922.50. Lake Shore Foundry Co., Cleveland, O.; 6-in., $27.33; 8-in., $27.13; 12-in., $26.83; 16-in., $26.53; 24-in., $26.43; $185,590.45. MacNeal Pipe & Foundry Co., Burlington, N. J.: $27.97 per ton for all sizes, $192,014.05. Dennis Long & Co., Louisville, Ky., $28 per ton for all sizes, $192,220.

Canal Work.—The Dominion Government has asked for tenders for the construction of the Sault Ste. Marie canal and for the enlargement of the St. Lawrence canals. The advertisement calls for the construction of a canal on the Canadian side of the river, through the island of St. Mary. As for the St. Lawrence enlargements, tenders are asked for the construction of two locks and the deepening and widening of the upper entrance of the Galop's canal; for the deepening and enlargement of the summit level of the Cornwall canal; the construction of a new lock at each of the three lock stations on the Cornwall canal between the towns of Cornwall and Maple Grove; the deepening and widening of the channel way of the canal; the construction of bridges, etc. With the Canadian Sault canal built, the St. Lawrence and Welland canals enlarged, and the use of the St. Clair flats guaranteed by treaty, Canadian vessels will have a right of way from Lake Superior to the ocean.

Street Material.—The following are the prices of bids received for street work by the Commissioners of the District of Columbia, at Washington: Removing old curb, 2 to 10 cts. per lin. ft.; removing old material, 3 to 15 cts. per sq. yd.; grading, 17 to 45 cts. per cu. yd.; haul per 100 ft. over 500 ft., ½ to 1 ct.; setting standard curb, 11 to 22 cts. per lin. ft.; resetting standard curb, 12 to 15 cts. per lin. ft.; setting special curb, 15 to 40 cts. per lin. ft.; combined curb and gutter, 39 cts. to $1.28 per lin. ft.; combined curb and gutter with conduit, $1.30 to $1.38; laying brick sidewalk, 13 to 20 cts. per sq. yd.; relaying brick sidewalk, 26 to 30 cts. per sq. yd.; laying asphalt tile sidewalk, 33 cts. per sq. yd.; laying sheet asphalt sidewalk, $1.35; laying artificial stone sidewalk, $1.87 to $2.18; repairing roadways, 6 to 9 cts. per sq. yd.; laying gravel roadway, 5 to 21¼ cts. per sq. yd.; laying bituminous base 50 cts. to $1.05; laying macadam roadways, 80 to 98 cts.; laying standard asphalt pavement, $2.25; laying combination asphalt with hydraulic base, $2; laying the same with bituminous base, $2; laying asphalt block pavement, $2; laying coal tar distillate and asphalt pavement, $2; granite block pavement, 55 to 95 cts.; granite block gutters, 60 to 95 cts.. granite blocks adjacent to railway tracks, 60 cts. to $1.45; cobble gutters, 12 to 35 cts.; gutter flag, 3 to 7½ cts. per lin. ft.; flag-crossing, 3½ to 9 cts per lin. ft. The following were the bidders: H. L. Cranford, Barber Asphalt Paving Co., P. Maloney, Andrew Gleason, T. H. Lyons, J. S. Ellis, Jas. Framley, Wm. Buckley, J. Cudmore, M. Hines, M. F. Tatty, Looney & Hurley, M. Fitzgerald, R. R. Pullman.

Pipe Line.—Russell & Alexander, of Colorado Springs, Col., have the contract for the West Monument pipe line for the Austin Bluffs Water Co. The line will be 9 miles long and is expected to be completed this year.

Depots.—The Chattanooga, Rome & Columbus R. R. Co. has rejected all the bids received for the construction of depots, and will have the work done by day labor. A. DIETZ, of Rome, Ga., is architect for the company.

Dredging.—Only one proposal for dredging at the training station, Newport, R. I., was received Aug. 7 by JAS. FULTON, Paymaster General, U. S. N., Navy Department, Washington, D. C., and that one was too informal to be considered.

Street Work.—At Burlington, Ia., the contract for the improvement of Arch St. has been awarded by WM. STEYH, City Engineer, at the following prices: earth excavation, 500 cu. yds. at 30 cts. per cu. yd.; curbing, 548 lin. ft. at 60 cts. per lin. ft.; gutter paving, 250 sq. yds. at $1.33 per sq. yd.; Telford paving, 1,030 sq. yds. at 72 cts. per sq. yd.

New Construction Companies.—The South & West Land Development & Railroad Construction Co. has been incorporated under the laws of Florida. Capital stock, $1,000,000. President, S. N. VAN PRAAG, of New Orleans.

The Southern Construction & Development Co. has been incorporated at Water Valley, Miss., by F. M. ABBOTT, J. H. BRINKER and R. C. BECKER.

The State Construction Co. has been incorporated at Camden, N. J., by PETER WIDENER, W. L. ELKINS and DAVID H. LANE, of Philadelphia. Capital stock, $100,000.

Asbestos.—The Bell Asbestos Co., of London, Eng., with a capital stock of $100,000, has purchased the asbestos mines of the Asbestos Packing Co., situated in the townships of Thetford and Coleraine, Que. The properties are very valuable ones, producing an excellent quality of asbestos and in great quantities, the output for the present year probably reaching from 1,000 to 1,200 tons of superior quality of No. 1 crude, and 400 to 500 tons of waste crude. A large shipment of the most improved asbestos machinery has arrived from England, and works will be established at Thetford, Que. THOMAS SHERIDAN, formerly of the Boston Asbestos Co., will be the manager.

Stand-Pipe.—The following proposals for a stand-pipe 20 ft. by 120 ft., have been received by GEO. A. ALLINSON, Superintendent of Water-Works, Burlington, N. J.: Shickle, Harrison & Howard Iron Co., St. Louis, Mo., steel tower, $12,800; R. D. Wood & Co., Philadelphia, Pa., $10,500 for steel tower, $9,950 for iron tower, $2,750 for foundations; John Baizley, $13,245, complete; Philadelphia Purifying Co., $10,445 for iron tower; Riter & Conley, Pittsburg, Pa., $9,689 for steel tower; Morris Tasker & Co., $10,306 for steel tower, $9,645 for iron tower, $2,362 for foundations; I. P. Morris & Co., $9,995 for iron tower; Tippett & Wood, $11,000 for iron tower; Porter Mfg. Co., $10,300 for steel tower, $9,825 for iron tower; Phœnix Iron Co., $11,225. The contract was awarded to Morris Tasker & Co., at $9,645 for an iron tower, and $2,362 for foundations.

Canal Work.—The following proposals for work on Guard Lock No. 3, and Lock No. 11, Oswego canal, were received Aug. 8 by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y.: Wm. Patrick, Fulton, N. Y., $19,086.25 for Guard Lock No. 3, $30,637.25 for Lock No. 11; Hughes Bros., Syracuse, N. Y., $19,111.50, $33,975; W. C. Rogers, Jordan, N. Y., $21,263, $37,492.50. The contract was awarded to Wm. Patrick. The contract for machinery for Lock No. 11 has been awarded to Wm. Patrick, for $2,655.75.——The following contracts have been awarded for lengthening 6 locks on the Erie canal: Costello, Nagle & Co., Elmira, N. Y.; No. 27, $24,356. No. 28, $26,595. Whalen Bros., Whitehall, N. Y., No. 29, $24,529. Hughes Bros., Syracuse, N. Y., No. 30, $32,851. B. P. Smith, Rochester, N. Y., No. 63, $23,655; No. 64, $24,971.53.

Mining in Honduras.—The Fonseca Mining & Milling Co. has been incorporated in New York to carry on operations in Honduras. Capital stock, $600,000.

Road.—At Winchester, Ky., the contract for building the Cabin Creek & Little Stover turnpike road has been awarded to Mason, Locker & Co., at $2,000 per mile.

Stone Arch Bridges.—Hy. Hurst & Co., have been awarded the contract for two stone arch bridges at Amsterdam, N. Y.; one over Old Fort creek, the other over Rogers creek.

Gas Holders.—The contract for building two gas holders, with capacities of 115,000 and 127,000 cu. ft. for the gas works at Alexandria, Va., has been awarded to Bartlett, Hayward & Co., of Baltimore, Md.

At Brooklyn, N. Y., a large gas holder, 136 ft. 6 ins. diameter, is being built for the Fulton Gas Co., by H. J. Davison & Co.

Sewers.—*Newark, N. J.*—Contracts have been awarded as follows, by ERNEST ADAM, City Surveyor: On Vesey St., Satchwell & Bellingham, 60 cts. and 28 cts. per ft. for 10-in. and 4-in. pipe, $100 each for basins. On 10th St., P. H. Harrison, $1.25, 84 cts. and 30 cts. for 15-in., 10-in., and 6-in. pipe, $105 each for basins. On Washington St., Thomas O'Connor, $1.25 and 35 cts. for 10 in. and 2-in. pipe, $100 each for basins, $90 each for flush tanks.

Pittsburg, Pa.—The Department of Awards has let the contract for the 33d St. sewer, 3 miles long, 2 miles being 7 and 8 ft. brick sewer, to Evan Jones, at $242,258.80. Also the contract for laying about 8 miles of 4 to 12-in. pipe, at $235,000. The contract for the Negley Ave. sewer has been awarded to Booth & Flynn.

Street Work.—*Pittsfield, N. H.*—The contract for concrete sidewalks has been awarded to C. H. Robie, of Manchester, at 50 cts. per sq. yd.

Brooklyn, N. Y.—The following proposals have been received by the Commissioner of City Works: For granite block paving on Bushwick Ave.: John Hart, $11.95 per lin. ft.; J. H. O'Rourke, $12; Thos. Monahan, $13.25; Charles Guidet, $14.81; Henry Mogk, $15.49.—For grading and cobblestone paving on Hamburg Ave.: James F. Gillen, $5.49 per lin. ft.; Henry Mogk, $5.99; H. A. Nolan, $6.34; John Hart, $6.75.—For grading and cobblestone paving on Woodbine St.: John Hickey, $2.98 per lin. ft.; Henry Mogk, $3.29; Charles Hart, $3.95.

Baltimore, Md.—Contracts have been awarded to T. O. Young, for grading, at 17¾ cts. per cu. yd.; and to Harden & Peddicord, for 38 cts. per lin. ft. for curbing, and 4⅞ cts. per sq. ft. for paving.

Sewer.—The following proposals for the construction of the Platt St. sewer have been received by W. C. SPAULDING, Auditor of the Board of Education, Cleveland, O.:

	Daniel Gawde.	Clements Bros.	L. T. Beers
No. 2 B brick sewer, per ft.	$1.26	$ 1.50	$ 1.44
No. 2. C brick sewer, per ft.	1.52	1.60	1.54
18 in. B brick sewer, per ft.	1.12½	1.20	1.24
18 in. C brick sewer, per ft.	1.20	1.25	1.34
Wooden culvert, per ft.	.10	.08	.07
15-in. sewer pipe, per ft.	.90	1.00	1.00
12 in. sewer pipe, per ft.	.80	.50	.75
12 in. catch basin pipes, per ft.	.55	.50	.55
15 in. junctions, each	.90	....	1.00
15-in. junctions, each	.50	.40	.70
9-in. junctions, each	.40	.30	.60
6-in. junctions each	.25	.19	.20
Catch basins, each	30.00	31.00	38.50
Manholes each	25.00	25.00	26.50
Flushing holes, each	11.00	9.00	7.50
Extra bricks, per 1,000	13.00	12.00	15.00
B. M. plank and timber, per 1,000 ft.	18.00	17.00	18.00

Pumping Machinery for Sale.—The Water Board, Boston, Mass., will receive bids for the following machinery, Aug. 22.:

One Worthington engine, compound duplex pattern; high-pressure cylinder 21-in. diameter; low-pressure cylinder 36-in. diameter; pump plungers, 17¼-in. diameter; stroke, 38 inches. In operation since March, 1878. Guaranteed capacity of builders, 3,000,000 per 24 hours. Daily average amount pumped in January, 1888, 4,064,500 galls. Daily average amount pumped in February, 1888, 3,967,900 galls. Duty developed from total coal yielding 16 per cent. ashes in February was 53,830,700 foot-pounds; lift, 146.45 feet.—Two non-condensing direct acting engines. Capacity of each, 1,800,000 galls. in 24 hours, with double-acting pumps, made by Boston Machine Co., of a capacity of 47 galls. per revolution. Steam cylinder, 20-in. diameter, 36-in stroke; water plungers, 14-in diameter, 36-in stroke. Fly-wheel, 15-ft. diameter. Distance from center of fly-wheel shaft to center of steam cylinder, 13 ft. 2¼ in.; from center of steam cylinder to center of pump, 8 ft. 8 in. In daily operation from 1870 to 1878 on alternate months, since then have been used as relief engines.

Bridge Contracts.—*East Aurora, N. Y.*—H. ELLSWORTH, the Highway Commissioner, has awarded the contract for the iron bridge over Cazenovia creek to the Groton Bridge Co., of Groton, N. Y., at $3,488. There will be one span of 104 ft. and one of 42 ft.

Jeffersonville, Ky.—The County Commissioners have awarded a contract for an iron bridge to the King Iron Bridge & Mfg. Co., of Cleveland, O., at $980.

Shelby, Ala.—A. King has the contract for a Howe truss wooden bridge, 200 ft. span, over Waxahatchie creek, for $1,375.

Kansas City, Kan.—The County Commissioners have awarded two bridge contracts to the Kansas City Bridge & Iron Co.

Fremont, Wis.—The Wisconsin Bridge Co., of Milwaukee, Wis., has the contract for the new bridge.

Los Angeles, Cal.—The contract for the iron bridge at Downey Ave., across the Los Angeles river, has been awarded to the California Bridge Co., for $38,500.

Wallaceburg, Ont.—The Smith Bridge Co. of Toledo, O., has the contract for an iron bridge, 148 ft. span, 18 ft. roadway, with two 5 ft. sidewalks.

Bridge Notes.—*Newton, Mass.*—The City Council has appropriated $5,000 towards the cost of an iron bridge at Newton Lower Falls. The town of Wellesley has appropriated a similar amount.

Enfield, Conn.—A new iron bridge is to be built over Freshwater river at Enfield St.; $2,500 will be appropriated for the purpose.

Mechanicsville, N. Y.—The new iron bridge is nearly completed. It is 500 ft. long, and was built by the Hilton Bridge Co.

Canisteo, N. Y.—The old wooden bridge at Depot St. is to be replaced with an iron structure.

Honesdale, Pa.—An iron bridge is being built across the Delaware river, between Little Equinunk, on the Pennsylvania side, and Hawkins Station, N. Y., L. E. & W. R. R., on the New York side.

Gaysport, O.—The Smith Bridge Co. will commence work at once on the iron bridge, and will try to complete it by October.

Clarksburg, W. Va.—The Harrison County Commissioners will build six new iron bridges in the county.

Parkersburg, W. Va.—A new iron bridge is to be built across the Little Kanawha river, negotiations for the repair of the old bridge having failed. The work will be advertised by the County Commissioners.

Tyrone, Ky.—The Louisville Southern R. R. Co. has contracted for a bridge over the Kentucky river.

Henderson, Ky.—The Ohio Valley R. R. Co. proposes to bridge the Ohio river at Henderson.

Nashville, Tenn.—Work has been commenced on the superstructure of the Hyde's Ferry Bridge, by the Mt. Vernon Bridge Co. The work will cost about $30,000 and will be completed in about 3 months. There will be two spans of 200 ft., a channel span of 250 ft., and 100 ft. of iron trestle. The bridge will be about 160 ft. above the river.

Rome, Ga.—The Chattanooga, Rome & Columbus R. R. Co. is at work on the Oostanaula river bridge. Work is also in progress on the Etowah river bridge.

Natchitoches, La.—At Washington, D. C., the bill authorizing the Natchitoches R. R. Co. to build a bridge over the Red river has been favorably reported to the house.

Chicago, Ill.—The Wells Street bridge is nearly completed. It is a steam drawbridge, with 2 roadways; is 200 ft. long, and will cost $59,000. It is built of steel and is paid for by the North Chicago City Ry. Co. The Keystone Bridge Co. had the contract.

Armurdale, Kan.—The old Argentine bridge is to be replaced with a new structure, at a cost of $30,000. Another bridge is proposed at Osage Ave.

Nebraska City, Neb.—The Chicago, Burlington & Quincy R. R. Co.'s bridge was opened July 28, and the first train crossed on that day. The bridge cost $150,000.

Los Angeles, Cal.—The City Council has decided upon 3 new bridges over the Los Angeles river. The cost will be $120,000, of which $70,000 will be paid by the city, and $50,000 by the railways.

Oregon City, Ore.—Work is in progress on the suspension bridge over the Willamette river. The main span will be 466.7 ft.

Quebec, Canada.—It is reported that English capitalists have been interested in the proposed St. Lawrence bridge, and that its construction is probable.

WATER.

Water Meters for Australia.—The South Australian Government has given an order that 2,000 water meters be manufactured in the colony, the value of the contract being between $30,000 and $35,000.

St. Paul, Minn.—JOHN W. HILL, consulting engineer, has reported upon the water supply in the wholesale district of St. Paul for the authorities of that city. The principal questions treated are the maximum capacity of the pipes entering and passing through this district, and the relation of these pipes to the capacity of the present steam fire engine plant. He also, in answer to queries, discusses the size of main required to supply 15, 20 and 24 fire engines, the question of cisterns *vs.* hydrants, the capacity in gallons per minute of the steam fire engines now used, and the best arrangement of fire hydrants and branch pipes for supplying them.

Chicago, Ill.—The land tunnels from 5th Ave. and Desplaines St. have been connected; these are two of the tunnels that will connect with the new lake tunnel. One is 850 ft. long and the other 2,000 ft. long. All the land tunnels will be completed this season and the West Harrison St. pumping works will be able to pump water next spring.

Water Works.—*New Hampshire.*—Claremont. The storage reservoir for the new works will be completed in November. The plant has been in operation since January.

Rhode Island.—Jamestown. The Jamestown Water & Gas Co. is having different sources of water supply investigated, and is arranging for pipe laying.—East Providence. There are now 52,898 ft. of mains, 51 hydrants, 527 services and 198 metres.

Massachusetts.—Salem. The Board of Aldermen has appropriated $800 for the investigation of the condition of the city's water supply.

New York.—Clyde. The water company has decided to supply the village with water from the Glover Springs.—Pulaski. There are now 131 houses supplied by the new works, and numbers of other connections are ordered.—Oswego. The water-works question has been settled and a contract signed. The franchise is for 15 years, and rental is $15,000 per annum.—Gowanda. Water-works are projected.—Cattaraugus. The proposition to issue bonds for water-works has been defeated.—Castile. A company is to be organized to build water-works. The supply will be obtained from springs at an elevation of 250 ft., and the cost is estimated at $10,000.—Albion. The water-works are approaching completion. Two wells are down, and others are being driven. The works are expected to be in operation by October. There is a large reservoir.

Maryland.—Baltimore. Ground has been purchased for the eastern pumping station.

Ohio.—Urbana. The city has ratified the contract with the Urbana Water-Works Co. The contract provides for 14 miles of mains and 110 hydrants, with a daily supply of 3,500,000 galls. Annual rental, $6,000.

Indiana.—Indianapolis. The City Board of Health is investigating the charge made by a Council committee, that the water company has been taking a foul supply of water from the river and the canal.—Columbus. New water-works are to be put in at a cost of $12,000.

Virginia.—Pocahontas. Water-works are projected and correspondence is invited. Address the mayor.

Tennessee.—Memphis. A new steel stand-pipe has been built by Riter & Conley, of Pittsburg. It is 26 ft. diameter and 160 ft. high. Its cost is $36,000.

Georgia.—Dalton. The water-works have been completed. They were built by L. Wagner, of Rome.—Cartersville. The city has awarded a contract for water-works to Jeter & Boardman, of Macon, Ga., who will begin work at once. The works will have a daily capacity of 1,000,000 galls., and will cost about $75,000.

Alabama.—Mobile. The mayor has vetoed the proposed contract with the Bienville Water Co. for a water supply for fire purposes.

Mississippi.—Vicksburg. The contractors have completed the pipe laying and are now working on the reservoir.

Michigan.—Mt. Clemens. Water-works have been contracted for. The water supply will be filtered, and there will be 7 miles of pipe and 105 hydrants. CHESTER B. DAVIS, of Chicago is the engineer.

Illinois.—East St. Louis. The City Water Co. is extending its mains and cleaning out the reservoir on the island. Meanwhile the city is supplied with unfiltered Mississippi water.—Bushnell. Water-works are to be built, and are to be completed by December. The water will be pumped to a stand-pipe. O. C. HICKS is City Clerk.

Iowa.—Des Moines. The water-works company is extending its pipe system, and will have 47 miles of pipe by the end of the season.

Wisconsin.—Ripon. The city has decided to have water-works, with 6 miles of pipe, and 60 or 80 hydrants.—Mazo Manie. The village will put in water works for fire protection.

Kansas.—Olathe. The water mains are being extended 2,600 ft.; and it is expected that the works will pay expenses.

Nebraska.—Holdrege. The water-works are completed. A. A. RICHARDSON, of Lincoln, Neb.; is the engineer.

Colorado.—Grand Junction. The water company has accepted the last contract proposed by the City Council, and work will be commenced at once on the stand-pipe system of works.

Nevada.—Tuscarora. The Tuscarora Water Co. has contracted for 12 miles of 8-in. iron pipe. There will be a daily supply of 600,000 galls.

Texas.—Marshall. The contractor for the Wagner system of wells, E. Sutphin, will commence work shortly. He will furnish a daily supply of 1,000,000 galls.—Greenville. A water company has been organized by J. W. HARRISON, L. B. NICHOLS and THOMAS HOWARD, of St. Louis, Mo., and T. H. KING, J. M. COOK and J. D. LASSATER, of Greenville. The works will cost $85,000.

Fresno, Cal.—An electric light franchise has been granted to Col. A. H. EMERY and others. It is provided that if ordered by the Council the company must take down its wires within 30 days and lay them underground.

Greenfield, Mass.—The Greenfield Gas Co. has chosen the following officers: President, F. R. ALLEN; Clerk and Treasurer, DANA MALONE; Auditor, W. C. SIMONS; Directors, F. R. ALLEN, W. N. WASHBURN, W. A. FORBES, F. A. POND, and J. D. SAFFORD. A semi-annual dividend of 2 per cent. has been declared.

New York City.—The following is the sewer work of the Department of Public Works for the quarter ending June 30. During the quarter, 19 contracts for the construction of sewers and 4 contracts for the construction of receiving-basins were completed; 13,127 lin. ft. of new sewers and 11 receiving-basins were built. The sewerage system now includes 424.61 miles of sewers, with 5,125 receiving-basins. At the close of the quarter, work was in progress on 42 sewer contracts.

Eureka, Cal.—The Ricks' Eureka Water-Works Co. has been incorporated to construct water-works and furnish a supply from Lawrence creek for domestic and other purposes. The company will also acquire all the property, rights and franchises of the present Ricks' Water-Works. The directors are C. S. RICKS, D. EVANS, H. H. BUHNE, Jr., W. H. PRATT and JOHN M. MELENDY. Capital stock, $200,000. Work has already been commenced. There will be a dam across the creek, and a tunnel 1,500 ft. long will have to be cut. A 20-in. main will be laid to convey the water to the distributing reservoir which will be located at an altitude of 150 ft. above the city. The length of the pipe from the creek to the reservoir will be about 20 miles, and the cost of the entire work is estimated at $125,000. The water is of excellent quality, and the quantity is sufficient to supply a city of 50,000 inhabitants. H. L. RICKS is Superintendent.

Sidney, O.—Plans for the new water-works have been prepared by GEO. HORNUNG, Consulting Engineer, of Cincinnati, O., and have been finally adopted. The old pumping plant with its present machinery and source of supply will be entirely abandoned. A different pumping station site has been selected on the west bank of the Great Miami river, where a new power house will be constructed to contain a pair of pumping engines, each with a daily capacity of 1,500,000 galls., and also a mechanical filtering plant with a daily capacity of 500,000 galls. There will also be a stand-pipe 25 ft. in diameter and 80 ft. high, erected on ground at an elevation of 118 ft. above the city. The above comprise the important features of the new works. Work on construction will commence as soon as possible, and it is expected that the new works will be completed and ready to be put into service during the early part of next year. The present system has about 6 miles of pipe, to which will be added another mile of pipe for connecting the new works, making in all about 7 miles of distributing mains. Proposals for the new works will be advertised for shortly.

Norfolk, Va.—The question of the quality and quantity of the water supply has been under consideration by the city, and the Board of Water Commissioners has submitted a special report. They deem it inexpedient to make any suggestions as to erecting a filter plant, owing to the expense, and consider that this matter should be delayed at least until the question of an ample supply is settled. The aerating plant is now being tested at the pumping station, but while it promises good results, they defer any definite report upon it until the tests are completed. The report endorses the recommendation of the late Water Board that the city should appropriate the necessary amount for making an experiment of the gang-well system. W. T. BROOKE, City Engineer, estimates the cost of an experiment, on the basis of a supply of 1,000,000 galls. per day, at $8,500. The wells would be about 40 or 50 ft. deep. One trial has already been made, and the water is found to be too hard for general use, and the report favors the admixture of the artesian water with the water from Lake Drummond, which, after passing through the aerator, is expected to result in an excellent quality of water supply. R. Y. ZACHARY, Superintendent of Water-Works, reports that the present pumpage is 3,000,000 galls. per day. The supply is drawn from Lake Lawson and Lake Bradford, but Lake Smith, which has a capacity equal to that of the other two combined, is not tapped. Mr. ZACHARY endorses the gang well project. Investigations for an artesian water supply have been made by HENRY E. KNOX, Jr., C. E., who discovered a water-bearing stratum 7 ft. deep, at an average depth of 40 ft.; which stratum he traced for about 8 miles. In his report Mr. Knox stated that after an experience of 10 years he had yet to see the first failure of a properly constructed system of gang wells.

A resolution has been adopted directing the Water Committee to consider the expediency of receiving bids for the sale of the property of the Norfolk City Water-Works for a sum not less than the water bonds now outstanding, purchasers to give proper guarantee to furnish the city of Norfolk and its citizens with a sufficient supply of good water at prices not exceeding the present rates.

Savannah, Ga.—Some time ago the city decided to draw its water supply from artesian wells, but before the city commenced work J. S. WHITESIDES bored a well for his private use, and at the depth of 325 ft. got a flow of about 250,000 galls. from a 6-in. pipe. Taking this well as a criterion the city started in with the intention of sinking about 5 wells. These wells were located from 75 to 100 ft. apart, all drawing from the same depth as Mr. WHITESIDES' well. After one or two of these wells had been sunk he discovered that his well was decreased in flow from 220,000 galls. to about 150,000, and the same proportionate decrease continuing with the increase in the number of wells, the city discovered that instead of 5 wells they had to bore some 16 or 18 to supply the amount of water required. Mr. WHITESIDES' opinion was that had these wells been placed about 300 ft. apart, one-half the number of wells would have furnished the same amount of water.

New York City Water Supply.—The following particulars are from the report of the Department of Public Works for the quarter ending June 30. During the entire quarter the natural flow of the Croton river furnished a full supply to the aqueduct, and the storage reservoirs and lakes in the Croton water-shed were filled to high water mark. During the first 6 months of the year a considerably larger supply could have been drawn from the Croton river and the storage reservoirs and lakes than the present aqueduct is capable of carrying. The supply drawn from the Bronx river is considerably larger per square mile of water-shed than that which the aqueduct is capable of carrying from the Croton water-shed. To obtain this comparatively larger supply, 335,000,000 galls. of water were drawn from the Kensico reservoir and the Rye Ponds reservoir. The rainfall was abundant. The water service was improved by 38,685 ft. of 6 to 36-in. pipe, 79 stop cocks, and 64 hydrants.

In extending the water meter system, 510 additional water meters were placed, making 17,412 meters in use at the close of the quarter. With the advent of the summer season there was a large increase in the use and waste of water, as shown by the fact that since June 4, the depth of water in the Central Park reservoir had been reduced 24 ins., equal to 56,000,000 galls. used in addition to the daily supply of 95,000,000 galls. received from the Croton river, and 18,000,000 galls. from the Bronx river. While a portion of this was undoubtedly due to the large increase in the number of buildings erected and occupied, a much larger share was due to excessive use and waste of water since the hot weather set in. The Department is using all the means in its power to suppress waste of water, and that these means are effective to a considerable extent is shown by the fact that the Department is still able to deliver water to every building in the city, while for some years past there has been a yearly average addition of 3,000 new buildings to be supplied with water. The means for suppressing waste, however, are not sufficient to prevent a gradual and steady decrease of pressure in the distributing mains to the extent that during the hours of the day when the consumption of water for domestic and business purposes is largest, the pressures are not sufficient to deliver water to many houses on high ground. In these buildings, however, a steady supply, during the day time, can be secured by the use of tanks, which can be filled at night by natural pressure when the use of water is smallest.

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest:

NEW WESTMINSTER, B. C., Aug. 1, 1888.

EDITOR ENGINEERING NEWS:—The Coquitlam Water-Works Co. (Limited) is to build a system of water-works to supply Vancouver, New Westminster and Port Moody, B. C., these places having a population of 8,000, 5,000 and 200, respectively. EDW. A. WILMOT is President of the company. Water will be taken from Coquitlam lake, 437 ft. above tide level, and conveyed by gravity to the consumers. The supply of water is unlimited and a uniform gradient can be maintained throughout the length of the pipe line, which will be through a soil of gravel and clay. It is now proposed to construct the pipe line to New Westminster, 80,000 ft. of 14-in. riveted steel or wrought-iron plates, and to use cast-iron for distributing pipes. The distance from New Westminster to Vancouver is 60,000 ft., making for the total length of pipe line 140,000 ft., or 24.4 miles. The company has a charter from the Government of Canada, and as the population and prosperity of both cities are constantly increasing, the financial success of the project seems certain. The necessity for water is imperative, as the rates of insurance are now 10 per cent. Each city is a terminal point of the Canadian Pacific Ry.

The estimated cost of works of first-class efficiency to supply the present population is $330,000. Capital for construction is partially secured, and the company is prepared to treat with capitalists on fair terms. Contracts for clearing were let to Duncan McKennon, New Westminster Junction, July 16. It is proposed to complete the works by October, 1889.

ARTHUR HILL, *Engineer-in-charge.*

ELLSWORTH, Me., Aug. 9, 1888.

EDITOR ENGINEERING NEWS:—The Ellsworth Water Co. proposes to supply this village of 6,000 people with water pumped from Branch pond to a stand-pipe, the cost of the system to be $80,000. Capital for construction has not yet been secured, but it is not proposed to begin work until June, 1889. A. W. CUSHMAN, is President of the company. C. C. BURRILL, *Chairman, Water Board.*

NAUGATUCK, Conn., Aug. 7, 1888.

EDITOR ENGINEERING NEWS:—The Naugatuck Water Co. began the construction of water-works Aug. 4. The supply will be taken from Straitsville brook, by gravity and the system is estimated to cost $80,000. The company's Engineer is J. H. MCKENZIE, of Southington, Conn. The contract for masonry, reservoir and buildings has been let to FRANKLIN A. SNOW, of Providence, R.; I. the other contracts have not yet been let. The present address of both engineer and contractor is Naugatuck. The mains will be of iron. HOMER TWITCHELL is President of the company. Population, 6,000. S. S. SCOTT,
Secy. & Treas., Naugatuck Water Co.

CEDAR RAPIDS, Ia., Aug. 4, 1888.

EDITOR ENGINEERING NEWS:—We are laying two miles of water mains and drilling three artesian wells. One well is down 2,235 ft. and flows 432,000 galls. in 24 hours. The second well is down 900 ft. The three wells will cost about 175,000. The new 2,000,000-gall. high duty Worthington engine has been accepted and is working well. All told, the company will expend about $35,000 for water-works improvements this year on account of the demand for water from the new wells and because of the new sewerage system put in by the city at a cost of $100,000. E. J. FOX, *Supt., Cedar Rapids Water Co.*

ANDOVER, Dak., Aug. 2, 1888.

EDITOR ENGINEERING NEWS:—H. D. BRACH, of Huron, Dak., has just finished laying 1,400 ft. of Kalamein pipe connecting with an artesian well belonging to the railroad company. This comprises our water-works system. Population, 350. W. CARPENTER, *Supt.*

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 118).

Socorro, N. M.—The works were commenced March 22, 1887, and completed May 21, 1887. They were designed and built by GEO. T. WOOLSTON, of New York. The pipe and specials were supplied by the National Tube Works Co., and the valves and hydrants by the Ludlow Valve Mfg. Co., of Troy, N. Y. The water is supplied by gravity from a mountain spring; there is a reservoir with a capacity of 500,000 galls. There are 5½ miles of pipe, and 25 hydrants; the mains are of kalomien pipe and the services of iron. The average daily consumption is 200,000 galls. Ordinary and fire pressure, 65 lbs. Cost of works, $30,000; debt, $30,000, city bonds; rate of interest, 6 per cent. The works are owned by the city and managed by a committee of the City Council. Present population, 4,100. (Date of special report; March 8, 1888.)

Phœnix, Ariz.—The works were commenced Jan. 1, 1887, and completed in May, 1888. W. T. HUTCHINSON was Constructing Engineer. The contractors for material were H. P. Gregory and W. T. Garratt, of San Francisco, Cal. There is a wooden pump and engine house on stone foundations, and the tank stands on 3 piers, 2 ft. wide and 24 ft. long. The supply is taken from wells; the day supply is pumped to a tank with a capacity of 20,000 galls., at an elevation of 60 ft.; the night supply is pumped to a stand-pipe 150 ft. high. The water is pumped by a Blake engine, 4-in. suction, with a daily capacity of 250,000 galls.; steam is supplied by a 40 H. P. boiler. There are 5 miles of 5-in mains, the pipe laid 18 ft. deep; 18 fire hydrants with 3-in. nozzles, and 300 taps; the mains are of cast-iron, and the services of enamelled iron. The average daily consumption is 50,000 galls. Ordinary pressure, 80 lbs.; fire pressure, 150 lbs. Cost of works, $25,000; debt, $5,000; rate of interest, 12 per cent. per year. There are about 800 consumers. The works are a private enterprise, and are owned by J. J. Gardiner & Son; President, J. J. GARDINER; Secretary and Superintendent, J. M. GARDINER. The city has granted a franchise of 50 years, and the average rent is $3. The present population is 5,000. (Date of special report; Feb. 18, 1888.)

(TO BE CONTINUED).